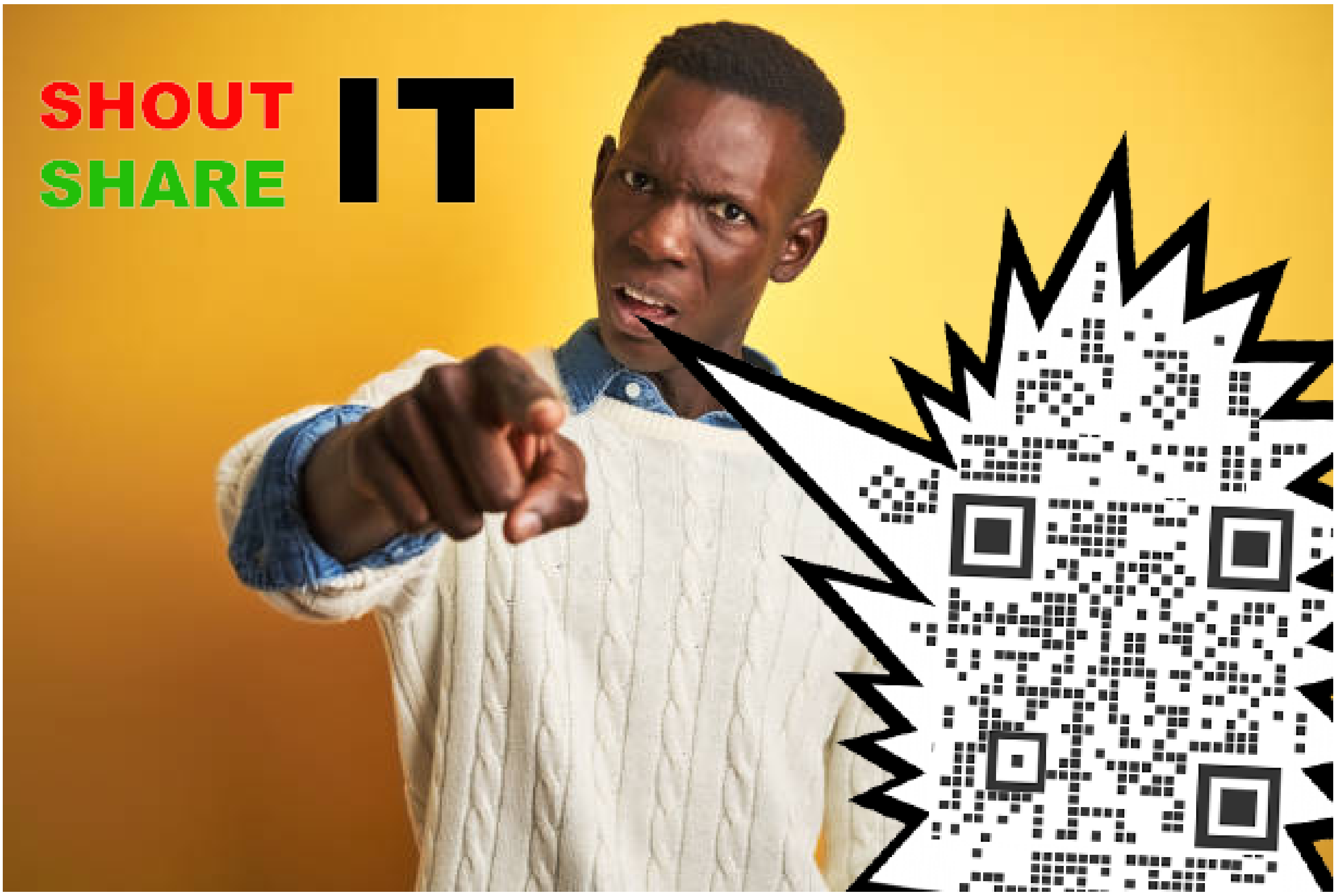
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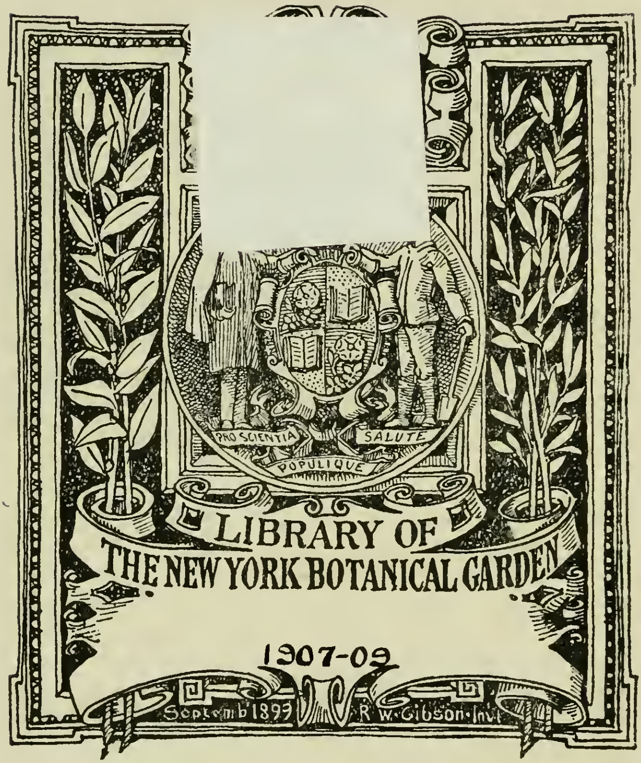

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CONTRIBUTIONS FROM THE NEW YORK BOTANICAL
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# PHYCOLOGICAL STUDIES—III. FURTHER NOTES ON HALIMEDA AND AVRAINVILLEA

By MARSHALL AVERY HOWE

NEW YORK
1907

[From the BULLETIN OF THE TORREY BOTANICAL CLUB **34**: 491-516. *pl. 25-30.* 1907]

[From the BULLETIN OF THE TORREY BOTANICAL CLUB 34: 491-516, *pl 25-30.* 1907]

# Phycological studies — III. Further notes on Halimeda and Avrainvillea

MARSHALL AVERY HOWE

(WITH PLATES 25-30)

## A. ON THE SPORANGIA OF HALIMEDA TRIDENS AND OF HALIMEDA TUNA

The sporangia of the genus *Halimeda* were for many years known only in the single species *Halimeda Tuna*,* though in 1876 Zanardini † briefly described those of *H. macroloba* and in 1880 Schmitz ‡ contrasted the characters of the sporangiophores of *Halimeda Tuna* with those of *H. platydisca.* But the true *Halimeda platydisca* Decaisne, according to the original preserved in the Muséum d'Histoire Naturelle of Paris, appears to be simply a large form of *H. Tuna*,§ and whether Schmitz was really dealing with two distinct species or with two forms of *H. Tuna* is not altogether clear. In 1904, Mrs. Gepp || described and illustrated in detail the sporangia and sporangiophores of *Halimeda gracilis*

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* Derbès & Solier, Suppl. Compt. Rend. 1: 46, 47. *pl. 11. f. 18-22. pl. 12. f. 1-5.* 1856.

Bompard, Hedwigia 6: 129. 1867.

Zanardini, Mem. R. Ist. Ven. 19: 541-543. *pl. 30.* 1876.

† Zanardini, *l. c.* 543.

‡ Sitzungsber. d. niederrheinischer Ges. f. Natur- und Heilkunde 1880: 140-146. 1880.

§ Barton, E. S. The genus *Halimeda.* Siboga-Expeditie, Monographe 60: 14. 1901. The present writer, after examining the same type, concurs with the monographer of "The genus Halimeda" in the opinion that *H. platydisca* does not offer any satisfactory characters in form or structure to distinguish it from *H. Tuna.*

|| Gepp, E. S. The sporangia of *Halimeda.* Jour. Bot. 42: 193-197. *pl. 461.* 1904.

and *H. Tuna*, using for her studies of the latter, through the courtesy of M. Ed. Bornet, "a portion of the identical specimen" described by Derbès & Solier. Mrs. Gepp in this paper brought out some especially interesting facts in regard to the relation of the sporangiophores to the filaments of the central strand.

In 1905, in distinguishing the newly recognized species *Halimeda scabra*, an ally of *H. Tuna* from Florida and the Bahamas, the present writer * described and figured its sporangia and alluded to a fertile specimen of *H. Tuna* collected in Bermuda. In view of the rarity of the occurrence of fertile specimens in this genus, it may be remarked that the Bermuda specimen was found in the month of June and the Florida specimen of *H. scabra* on March 30.

In each of these cases only a single plant out of the many observed was fertile. But on March 3, 1906, near the mouth of the main harbor of Culebra Island, Porto Rico, the writer found, growing near the low-water mark, an abundance of *Halimeda Tuna* laden with sporangia. The photograph published herewith (PL. 27, FIGS. 2–4) gives an idea of the appearance of these fertile specimens and of the position of the sporangia upon them. The sporangia occur chiefly in crowded clusters on the margins of the segments, but they are also often scattered over the discs or flattened faces of the segments, which they occasionally cover almost completely. Derbès & Solier and Mrs. Gepp describe and figure the sporangia of *Halimeda Tuna* as occurring only on the margins of the segments, but Zanardini both describes and illustrates them as occurring also on the discs. The sporangiophores are 1–2 mm. long and both in these Porto Rican and in the Bermudian specimens they are apparently rather more simple (PL. 25, FIGS. 7–9; PL. 28, FIGS. 1 and 2) than those of the European *H. Tuna;* at least, we have never observed the forking which Mrs. Gepp has described and figured (*l. c., f. 6*) as occurring immediately after the fusion of their basal filaments. All the sporangiophores that we have seen are either simple or once dichotomous near the top — somewhat resembling Derbès & Solier's *figure 2*. Those springing from the margins of the segments (PL. 25, FIGS. 8, 9, 10) are formed by the fusion of two or three filaments of the central strand, but those springing from the discs or flattened faces come directly

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* Bull. Torrey Club 32: 241–244. *pl. 11, 12.* 1905.

from the medullary filaments, in most cases, at least, without any fusion, and often apparently lateral in origin (PL. 28, FIGS. 1 and 2). This latter condition is at variance with Mrs. Gepp's conclusion (*l. c.*, p. 196) that in both the vegetative and reproductive parts of *Halimeda* "all fresh growth is preceded by a fusion of filaments of the central strand," but in the specimen examined by Mrs. Gepp the sporangiophores apparently arose only from the segment-margin, in which case in the American plants also fusion is the rule and perhaps universal. The sporangia of these Porto Rican specimens vary from pyriform-obovoid to subglobose and are 0.20–0.33 mm. broad; in arrangement they are somewhat botryoid or irregularly distichous. The plants were kept for a time in a jar of sea-water with the hope that the living zoospores might be seen, but the experiment was unsuccessful, probably on account of lack of continuous observation.

On March 22, 1906, the writer was so fortunate as to find near Tallaboa on the southern shore of Porto Rico, growing in about one meter of water (low tide), two fertile specimens of *Halimeda tridens*,* a species which seems to have been known previously only in a sterile condition, though it was originally described as long ago as 1786 and has since been often collected. A photographic representation of one of these plants is given on PLATE 27, FIG. 1. In comparing it with the fertile specimens of *H. Tuna*, one is impressed at first by the very different color of the sporangia, which are uniformly yellowish-brown or of a burnt-umber shade, while those of *H. Tuna* are uniformly of a bright, dark, intense green. The sporangiophores are the most densely clustered along the upper margins of the segments, especially at the apices of the lobes when lobes are present, but they may emerge from any part of the segment and sometimes completely cover its surface. The second plant, the one not shown in the photograph, is the more densely laden with sporangia, and some of its branches are so thoroughly covered as to obscure their segmentation. The sporangiophores are a little longer than those of *H. Tuna*, ranging from 1.3 to 2.3 mm. in length, and they are much more branched, being 1–5 times dichotomous. We have not seen one wholly simple. The sporangiophores that spring

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* For remarks on the name of this species, see page 501.

from the margins of the segments (PL. 28, FIG. 3) are mutually coherent near the point of emergence and communicate with each other there by pits or pores like the vegetative filaments of the central strand at the nodes, but the sporangiophores from the disc-surfaces originate as direct continuations of the peripheral utricles or of the utricles of the subcortical layer and are without fusions or adhesions of any kind (PL. 28, FIGS. 4–7). The sporangia are obovoid or pyriform and are 0.20–0.38 mm. broad. The callose or mucous plugs which we have described * as forming basal septa of a certain sort for the sporangia of *Halimeda scabra* we have not observed in *Halimeda tridens;* such are, however, of occasional and irregular occurrence in the Porto Rican material of *Halimeda Tuna.*

## B. ON THE AMERICAN SPECIES OF THE HALIMEDA TUNA GROUP

At the time of describing the strongly marked species *Halimeda scabra,*† attention was directed to another species which likewise had commonly been confused with *Halimeda Tuna.* Of this "smooth plant of the *Tuna-cuneata* alliance," we remarked, "It seems rather violent to identify it either with *Halimeda Tuna* or with *H. cuneata,* and it is possible that further acquaintance with it will show constant and reliable characters for distinguishing it from both." At that time nearly all of our American material of the *Tuna* group belonged to this "species inquirenda" and to *H. scabra* and the only specimens we had seen from the American side of the Atlantic which we could refer to *H. Tuna* were from Bermuda. But since then we have collected what we believe to be the true *H. Tuna* both in Porto Rico and in Jamaica and have seen a specimen of it purporting to come from Key West, Florida, so it now seems probable that both it and its ally are of general distribution in the West Indian region. And the two "forms," so far as we have seen them, are always absolutely and abundantly distinct and in our opinion are as much entitled to be considered specifically different from each other as are *Halimeda Tuna* and *H. Opuntia* or *Halimeda Tuna* and *H. scabra.* It soon became evident that this ally of *H. Tuna* had already been recognized as a species, and it appears that the earliest available name for it that conforms with prevailing rules of nomenclature is *Halimeda discoidea* Decaisne,* under which name the species is described below:

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* Bull. Torrey Club **32**: 243. 1905.

† M. A. Howe, Bull. Torrey Club **32**: 241–244. *pl. 11, 12.* 1905.

HALIMEDA DISCOIDEA Decaisne, Ann. Sci. Nat. II. **18**: 102. 1842.

? *Halimeda papyracea* Zanard.† Flora **34**: 37. 1851; Mem. R. Ist. Ven. **7**: 288. *pl. 13. f. 2.* 1858.

Of a light bright-green color and lubricous when living, becoming yellowish- or albescent-green and more or less pergameneous or papyraceous and smooth to the touch on drying, suberect or decumbent, 5–15 cm. in height or length, subsessile, very lightly calcified, the calcification usually confined to the narrow area lying between the coherent ends of the peripheral utricles and the distal ends of the subcortical utricles, in the oldest parts sometimes involving the distal half of the subcortex; the branching in one plane, mostly frequent or somewhat congested, usually di- or trichotomous, the larger subbasal segments sometimes originating five or six branches: segments discoid, enervate, deltoid-obovate, semiorbicular, reniform, or subelliptical (with longer axis transverse), 6–35 mm. broad, mostly 0.3–1.2 mm. thick, those near base scarcely different, but sometimes attaining thickness of 1.75 mm., margins entire, the surfaces commonly nitent when dry or in younger parts dull and very minutely spongiose: peripheral utricles mostly hexagonal in surface view, 40–85 $\mu$ in diameter, often fusing in twos, threes, or rarely fours, and therefore appearing

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[*] The name *Corallina discoidea* Esper (Pflanzenthiere, Fortsetz. 2, *Corallina*, *pl. 11.* 1798–1806) appears to have fallen short of effective publication according to both the Vienna and the Philadelphia codes of nomenclature, so may be ignored in determining the correct name of the present species, whether Esper had this species before him or not. The name first appeared on a plate, illustrating a large *Halimeda* of the *Tuna* group, without analysis of parts and without descriptive or explanatory text. In a continuation of Esper's work by F. L. Hammer, many years later (3: 356. 1830), the name (changed to "discoïdes") is found in the synonymy of *Halimeda Tuna*, with a reference to the plate. Esper's plant cannot be satisfactorily determined without examining the original, which, it would seem, is not now to be found in his collections preserved at Erlangen. Lamouroux is sometimes quoted as having a *Halimeda discoidea* but it would appear that he never actually published such a binomial. In 1812, in establishing the genus *Halimeda*, Lamouroux mentions among the examples *Corallina* "*discoidea* Esper," but we do not find that he ever actually printed or adopted the name *Halimeda discoidea*. In the same paper he mentions "*Corallina flabellum* Ell." as an example of his new genus *Udotea*, but when four years later he came really to enter the species into *Udotea* it became *Udotea flabellata* instead of *Udotea Flabellum*.

[†] See footnote on following page.

larger and of irregular outline, mostly subquadrate, subquadrate-oblong or cyathiform in lateral view, less commonly cornucopiaeform, 65–150 μ long (including the usually slender stalk), truncate at apex, in firm contact above with those adjacent for $\frac{1}{5}$–$\frac{2}{3}$ their length, often interlocked, separable with much difficulty on decalcification: utricles of the subcortical layer in a single series, bullate, varying from broadly funnelform to subglobose or ellipsoidal, mostly ventricose-obovoid, 110–215 μ in maximum width, always much larger than the peripheral utricles, 4–14 of which commonly arise from the subtruncate apex of each: filaments of the central strand fusing in twos or rarely in threes at the nodes, not coherent, the fusion often incomplete: sporangia unknown. [PLATE 25, FIGURES 11–20; PLATE 26.]

TYPE LOCALITY: Unknown ("Kamtschatka, Voyage de la Vénus," according to presumably erroneous label); type specimen in the herbarium of the Muséum d'Histoire Naturelle in Paris.

DISTRIBUTION: Southern Florida and the West Indies; Hawaii; Celebes; Red Sea; probably of general distribution in the tropical seas.

In giving the distribution of the species as above, we are guided only by specimens now in the herbarium of the New York Botanical Garden. Both *Halimeda discoidea* and *H. Tuna* occur in Oahu, Hawaiian Islands. We have specimens of *Halimeda Tuna* also from the Philippines, Singapore, and from some of the East Indian islands visited by the Siboga Expedition, and it seems probable that both *H. Tuna* and *H. discoidea* have a wide distribution in the tropical parts of the Indian and Pacific oceans, as well as of the Atlantic. Askenasy's *figure 11* (Forschungsreise S.M.S. Gazelle 4: *pl. 4*) was very certainly drawn from a specimen of *H. discoidea*, apparently from Dirk Hartog Island, Western Australia, though it was identified by Askenasy with the quite different *H. macroloba* Decaisne. The specimen of *H. discoidea* from the Red Sea, which we have cited above, was collected by Boissier in 1855 (*no. 5*) and was distributed as *H. macroloba*. This specimen resembles very closely Zanardini's figure of his *Halimeda papyracea*, the type * of which also came from the Red Sea. The specimen from the Celebes which we have cited was distributed as *Halimeda Lessonii* Bory, but we have no conclusive proof that it is an authentic representative of what Bory intended to have bear this name. Moreover, this alleged name of Bory's, so far as the literature of the subject is concerned, appears to be merely a "nomen nudum" without even an indication of the source of the specimen beyond what one may infer from the name itself, and it therefore deserves no recognition in synonymy.

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* We have been unable to locate the type specimen of Zanardini's *Halimeda papyracea*, which does not appear to exist in his herbarium now preserved in Venice. Mrs. Gepp, in her monograph of the genus *Halimeda* (p. 15), mentions that she had been allowed to see this type specimen "through the kindness of Dr. Beccari." Dr.

*Halimeda discoidea* has of late been confused chiefly with *H. Tuna* forma *platydisca* (Decaisne) Barton. The original specimen of *H. platydisca* Decaisne (in herb. Mus. Paris.), as already determined by Mrs. Gepp, seems to be simply a very large condition of *Halimeda Tuna*. Its peripheral utricles show occasional fusion, but they have the form and light contact of *H. Tuna* and the utricles of the subcortical layer also are those of *H. Tuna* and the plants have the heavier calcification of that species. The segments of *Halimeda discoidea* are usually but not always larger and more inclined to be obovate than those of *H. Tuna* and by these characters, together with the lighter calcification of *H. discoidea*, the two species can usually be distinguished at sight, but reliable diagnostic characters can always be found in the amount of contact of the peripheral utricles and in the form and size of the utricles of the subcortical layer. The more important histological characters of the two species are contrasted below:

| | *Halimeda Tuna* | *H. discoidea* |
|---|---|---|
| *Calcification.* | Moderate. Involving subcortical layer, often also the medulla and the bases of the peripheral utricles but rarely extending to the surface. | Slight. Usually confined to the distal ends of the utricles of the subcortical layer. |
| *Peripheral utricles.* | Rounded-truncate, 30–70μ in diameter, very rarely fused, in contact above with those adjacent for $\frac{1}{20}$–$\frac{1}{3}$ their length, not interlocked, rather easily separable on decalcification. | Truncate, 40–85μ in diameter, often fused, in contact above with those adjacent for $\frac{1}{5}$–$\frac{2}{3}$ their length, interlocked, separable with much difficulty on decalcification. |

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O. Beccari, of Florence, in response to our request to see this type, has sent us a fragment of a plant collected by himself at Singapore, with the explanation that it is a portion of the specimen examined by Mrs. Gepp. This Singapore plant, which had been labeled *Halimeda papyracea* Zan., is evidently a form of *H. Tuna*, as already determined by Mrs. Gepp.

| | | |
|---|---|---|
| *Utricles of subcortical layer.* | Subturbinate, obconical, cornucopiaeform, or clavate, 35–110 $\mu$ in maximum width, often scarcely larger than the peripheral utricles. | Bullate, varying from broadly funnelform to subglobose, mostly ventricose-obovoid, 110–215 $\mu$ in maximum width, always much larger than the peripheral utricles. |
| *Nodal filaments of the central strand.* | Fusing in twos or threes, often somewhat coherent just above the points of fusion. | Fusing in twos, rarely in threes, not coherent, the fusion often incomplete. |

In addition to the differences mentioned above, the utricles of the subcortical layer form a more compact flat-topped stratum in *H. discoidea* than in *H. Tuna,* as will be seen by comparing FIGURE 11 with FIGURE 1. It should be mentioned that in drying the large utricles of the subcortex of *H. discoidea* commonly collapse and are flattened against the medulla and often revive imperfectly on being soaked out; this is especially true of specimens which have been long in herbaria and it doubtless explains why this striking peculiarity has not received earlier recognition.

In the firm and extensive contact of the peripheral utricles, *Halimeda discoidea* bears some resemblance to *Halimeda cuneata* Hering, originally described from Natal Bay, but otherwise the two have little in common. We have not seen Hering's original specimen, but have examined a plant from Natal agreeing in every respect with his description. In this, the peripheral utricles measure 27–44 $\mu$ in diameter, surface view, and show no evidence of fusion; they are 60–110 $\mu$ long, are in close contact distally for $\frac{1}{4}$–$\frac{2}{5}$ their length, are obconical or clavate, surmounted in a somewhat capitate fashion by the coherent distal parts, which appear subquadrate in a radio-vertical section. The utricles of the subcortical layer are only 27–55 $\mu$ in maximum diameter, scarcely larger than those of the peripheral stratum, are 2–4 times dichotomous (*i. e.*, in 2–4 series), and obconical, ovoid-turbinate, or clavate. The nodal filaments of the central strand fuse in twos and threes and are strongly coherent just above the points of fusion, as well described by Mrs. Gepp (*l. c.* 15–17). Branches given off from the filaments near the points of fusion form a compact narrow annular cushion above which the filaments are naked and subtorulose. This annular nodal cushion we have observed in no other species. The segments of *H. cuneata* are cuneate-obdeltoid and are almost without exception longer than broad. The very different utricles of the subcortical layer, with other characters, well distinguish *H. cuneata* from *H. discoidea* and we think it clearly entitled to specific rank. In any event, if one's conception of specific limitations should prove sufficiently elastic to include the two under one specific name, Decaisne's *Halimeda discoidea* has the right of way on priority grounds.

The older writers on the species of *Halimeda* gave very little attention to histological characters. Kützing,* indeed, remarked upon the uniformity of their structure and considered it unnecessary to give detailed figures illustrating the anatomy of each species. Professor Askenasy † in 1888 made an important advance in describing and figuring the details of structure and in emphasizing their value in distinguishing species, but he apparently did not examine authentic material of certain species described by his predecessors, and thus quite naturally made a wrong application of some of the specific names. Mrs. Gepp (Miss Ethel Sarel Barton) in preparing her monograph of "The Genus Halimeda" (*l. c.*) recognized fully the importance of seeing original materials and rendered an important service by investigating carefully the characters of the nodal filaments of the central strand and insisting on the value of these characters in diagnosing species, but she did not emphasize sufficiently the characters of the peripheral utricles and the utricles of the subcortical layer, parts which, in most species, at least, offer peculiarities of as much constancy and value as do the nodal filaments. That the nodal filaments are not altogether invariable is seen in *Halimeda discoidea*, where fusions of the *H. Tuna* type and of the *H. Opuntia* type sometimes occur side by side in a single node (FIGURES 19 and 20) and also in *H. Monile*, in which rarely the filaments are only superficially coherent. The peripheral utricles and those of the subcortical layer also have, of course, a certain range of variation in each species; nevertheless that range is limited and these elements possess characters of taxonomic value of which any final and complete system of classification must take cognizance.

The specimens from Bermuda, Porto Rico, and Jamaica, which we have identified with the Mediterranean *Halimeda Tuna* present some slight peculiarities which, however, we believe are not sufficiently constant and reliable to warrant a specific separation. In the first place, the American plants are more rigid and rather more calcified than the European specimens that we have seen. When growing, they are commonly suberect and cespitose, while according to Oltmanns* the flat Halimedas of the Mediterranean ("*Tuna*, *platydisca*") have a more or less horizontal or pendulous position. The diameter of the peripheral cells averages about 6–12 $\mu$ less than in the European specimens examined, though no smaller than in certain Adriatic representatives of *H. Tuna*. The filaments of the central strand, as shown in our FIGURES 5 and 6, are often inclined to cohere strongly at the node just above the points of fusion, while those of *H. Tuna* are usually easily separable under treatment, as described by Mrs. Gepp†; however, we have seen a specimen from the Adriatic (leg. Titius) in which the tendency of these filaments to cohere at the nodes is as pronounced as in the plants of Bermuda and Porto Rico, and Mrs. Gepp mentions (*l. c.*) a similar condition in a specimen brought from Rangiroa by Professor Agassiz. The sporangiophores in the American specimens appear to be rather more simple than those of the European *H. Tuna*, as we have noted above.

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*Tab. Phyc. 7 : 9. 1857.

† Forschungsreise S.M.S. Gazelle 4 : 11–14. *pl. 3, 4.*

The American species of the *Halimeda Tuna* group, thus far recognized, may be distinguished by the use of the following key‡:

Peripheral utricles truncate or rounded-obtuse.
  Peripheral utricles in contact for $\frac{1}{5}$ their length or less; utricles of the subcortical layer subturbinate, obconical, or clavate, 35–110 $\mu$ in maximum diameter. *H. Tuna.*
  Peripheral utricles in contact for $\frac{1}{5}$–$\frac{2}{3}$ their length; utricles of the subcortical layer bullate, mostly ventricose-obovoid, 110–215 $\mu$ in maximum diameter. *H. discoidea.*
Peripheral utricles galeate-cuspidate. *H. scabra.*

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* Morph. and Biol. Alg. 1: 295. *f. 182;* 296. 1904.

† Siboga-Expeditie. Monographe 60: 16. 1901.

‡ Excluding *Halimeda gracilis* Harv., which agrees essentially with the members of the *Halimeda Tuna* alliance in the character of the nodal filaments, but differs considerably in the form of the segments. The type of *H. gracilis* was from Ceylon, but a specimen dredged by the Challenger Expedition at St. Thomas, West Indies, in 5 to 15 fathoms of water, appears to agree with it in most respects, though the peripheral utricles are larger and more coherent and the utricles of the subcortical layer are very long (mostly 300 to 700 $\mu$).

## C. ON THE AMERICAN SPECIES OF THE HALIMEDA TRIDENS GROUP

Even before writing "Phycological studies — II," * in which we described *Halimeda favulosa* as a new species and followed Mrs. Gepp (Ethel S. Barton) and also Harvey in considering *Halimeda Monile* (Ell. & Soland.) Lamour. a mere variety or form, we had seen both *Halimeda tridens* † (*H. incrassata*) and *H. Monile* growing in close proximity to each other in Bermuda, in Porto Rico, and in the Bahamas, and remaining apparently distinct. But the segments in both of these were subject to so much variation in outward form, even in different parts of a single individual, that plants from other localities would sometimes appear to occupy an intermediate position, and great as were the manifest differences between the best representatives of these two types it seemed difficult to draw any satisfactory line between them. When, however, in December, 1906, and January, 1907, we again saw, in several localities in Jamaica, *Halimeda tridens* and *H. Monile* growing either side by side or within a few feet of each other and always maintaining their distinctive characters perfectly, the conviction was forced upon us that a mistake had been made in considering them forms or varieties of one species and that in addition to their more obvious peculiarities a careful comparison under the microscope would be likely to reveal histological characters of diagnostic value. We have now been able to compare microscopically specimens representing fifty-seven collection-numbers of these two "forms" from Bermuda, southern Florida, and the West Indies, and the results are of interest. In *Halimeda tridens* the peripheral utricles show a range of from 49 to 77 $\mu$ in average maximum diameter in surface view; that is, on measuring the distal ends of each the longest way, the average in some individuals is as low as 49 $\mu$ and in others as high as 77 $\mu$. In the representatives of *H. Monile*, the peripheral utricles, measured in the same way, range from 30 to 44 $\mu$ in diameter; and they are more strongly coherent after decalcification, their lateral walls being in contact for $\frac{1}{3}$–$\frac{1}{10}$ their length *vs.* $\frac{1}{8}$–$\frac{1}{20}$ their length in *H. tridens*. And the utricles of the subcortical layer, at least those of the outmost series, are narrower and less rounded than in *H. tridens*, being 24–55 $\mu$ in greatest width *vs.* 35–95 $\mu$, and obconical, clavate, or obovoid, rather than turbinate, subglobose, or ellipsoidal. *Halimeda tridens* and *H. Monile* occasionally simulate each other in form, as indeed in an even greater degree do *Halimeda Tuna* and *H. scabra*, and it is not surprising that Lamouroux, Harvey, and others who have depended upon externalities have had doubts as to their specific distinctness; but we believe that they are really distinct and that they constitute species in the best sense of the word. Ninety-five per cent. of the specimens that one meets with can easily be referred at sight to the one species or the other, and in the case of the few that may seem doubtful on first inspection, an accurate measurement of the peripheral utricles has, thus far, afforded a satisfactory basis for determination.

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* Bull. Torrey Club 32 : 563–586. *pl. 23–29.* 1905.

† One who has seen an extensive series of West Indian Halimedas, either growing or in an herbarium, can scarcely have any serious doubts, we believe, as to the intended application of Ellis & Solander's names *Corallina tridens* and *Corallina incrassata* or as to the impossibility of drawing any reliable line of specific separation between the two. This being granted, the next question involves a choice between the two names, published in one work at the same time. Mrs. Gepp, in her monograph of "The Genus Halimeda" (Siboga-Exped. LX) has adopted the specific name *incrassata*, presumably because Ellis & Solander's description of their *Corallina incrassata* was accompanied by the more numerous and more detailed figures. The Rochester and the Philadelphia codes of botanical nomenclature give preference in such cases to the name having "precedence of position," which would here call for the adoption of the specific name *tridens*, the name which, fortunately, in America, at least, has been the more generally employed. The recent Vienna Code (Art. 46) provides that "when two or more groups of the same nature are united, the name of the oldest is retained. If the names are of the same date, the author chooses, and his choice cannot be modified by subsequent authors." In the case in hand, technical priority in the matter of publishing a choice between the two names appears to lie, by a narrow margin, so far as we can discover, with Mr. F. S. Collins, whose choice of *Halimeda tridens* appeared in print in November, 1901 (Proc. Am. Acad. Arts and Sci. 37 : 246) while Mrs. Gepp's monograph, in which the name *Halimeda incrassata* is preferred, bears the date of December, 1901.

In addition to *Halimeda tridens*, *H. Monile*, and *H. favulosa*, there is a fourth member of this alliance which we have thus far met with five times in Porto Rico, Jamaica, and the Bahamas, and which holds its distinctive characters so constantly in varying depths of water and under other diverse conditions that we believe it entitled to specific rank. A description of it follows:

**Halimeda simulans** sp. nov.

Dark- or rather light-green when living, sometimes becoming yellowish-green on drying, erect or somewhat flaccid, 6–15 cm. high, flabellate or subflabellate in habit, sessile or subsessile, the one or two lowest, more or less modified, flattened segments often forming a sort of stipe, strongly calcified, the calcification soon involving the medulla and reaching the outer surface of the peripheral utricles, the surface dull or slightly nitent, appearing smooth, solid, and compact, even under a lens; branching in one plane, usually trichotomous: rhizoids commonly forming a bulbous mass with the adherent sand: segments discoid, plane or obscurely 1- or 3-nerved, subquadrate-reniform, subquadrate, or rhombic-ellipsoidal, rarely obovate, nearly always broader than long, mostly subentire or 3–7-crenulate, sometimes 3-dentate or 3-lobed, 2–9 mm. long, 4–12 mm. broad, 0.5–2 mm. thick (those of extreme base now and then 3 mm. thick): peripheral utricles turbinate or subcrateriform, 27–80 $\mu$ long, 33–40 $\mu$ in average maximum diameter in surface view, truncate or rounded-obtuse, lateral walls in contact for $\frac{1}{3}$ to $\frac{1}{10}$ their length, usually cohering rather firmly on decalcification: utricles of the subcortical layer in a double, triple, or rarely quadruple series, those of the outmost series turbinate, obovoid, subglobose or ellipsoidal, 30–72 $\mu$ in maximum width, those of the inmost series obovoid, obconical, or clavate, 41–110 $\mu$ in greatest width: filaments of the central strand strongly coherent at the nodes, communicating there with those adjacent by open pits or very short tubular processes and exhibiting there thickened and often colored walls: sporangia unknown. [PLATE 29.]

Growing on a sandy bottom or occasionally on stones in 3 dm. of water and down to a depth of several meters. Porto Rico: *no. 4332*, type (Culebra Island, M.A.H. — also *no. 4383*); Jamaica: *nos. 4837b* and *4845* (Montego Bay); Bahama Islands: *no. 3561* (Frozen Cay, Berry Islands).

*Halimeda simulans* is a member of the *Halimeda tridens* (*H. incrassata*) group, being probably most nearly allied to J. Agardh's *Halimeda incrassata α. ovata* [Till Alg. Syst. 5: 86. 1887. —"Hab. ad insul. Noukahiva (Jardin)"] the evident type of which is no. 15892 in the Agardh herbarium at Lund. But the peripheral utricles of this Noukahiva specimen average 50 $\mu$ in maximum diameter, which would throw it into the form cycle of *H. tridens* according to the measurements which thus far have proved reliable in helping to distinguish the West Indian species of this group. The Noukahiva plant is also less calcified than our

*Halimeda simulans* and has some of the other minor peculiarities of the true *H. tridens.*

In its nearly sessile plants and in the form of its segments, *Halimeda simulans* sometimes outwardly resembles *H. Tuna*, but its segments are much thicker and more rigid than in that species and they commonly have marginal crenulations or sometimes short lobes which are wanting in *H. Tuna*; and the behavior of the filaments of the central strand at the nodes is very different in the two species. On Culebra Island, *Halimeda simulans*, *H. Tuna*, and *H. tridens* were found growing within short distances of each other, and no intermediates were discovered. On the outside shore of the outmost of the Bogue Islands, Montego Bay, Jamaica, on January 7, 1907, *H. simulans* was found growing side by side with *H. Tuna*, while within a few rods were *H. tridens* and *H. Monile*, and no forms showing any intergrading among these four species, as we prefer to call them, were observed. From Frozen Cay, Berry Islands, Bahamas, the only *Halimeda* that we brought away besides the *H. simulans* was one of *H. scabra*, but *Halimeda tridens* is in general rather common throughout the Bahamian archipelago.

A key to the American representatives of the *Halimeda tridens* group may be arranged as follows:

- Filaments of the central strand coherent at the nodes, communicating there with those adjacent by pits or very short tubular processes, rarely (now and then in *H. Monile*) merely thick-walled at the nodes and separable; segments flattened or subterete, often 3-lobed or 3-dentate.
  - Peripheral utricles less than 80 μ in average maximum diameter, surface view.
    - Peripheral utricles 49–77 μ in average maximum diameter, surface view; segments usually flattened. *H. tridens.*
    - Peripheral utricles 30–44 μ in average maximum diameter, surface view.
      - Segments mostly subterete. *H. Monile.*
      - Segments discoid (suggesting *H. Tuna*). *H. simulans.*
  - Peripheral utricles 175–190 μ in average maximum diameter, surface view. *H. favulosa.*

## D. ON THE SPORANGIA OF AVRAINVILLEA NIGRICANS

(PLATE 28, FIGURES 8–25)

On January 5, 1907, at Montego Bay, Jamaica, while washing and preparing some specimens of *Avrainvillea nigricans* and *A. longicaulis* (*A. Mazei*) which had been collected there in shallow water earlier in the day, our attention was arrested by one plant of *Avrainvillea nigricans*, the surface of which was rather abundantly covered with protruding capitate or subclavate filaments. Remembering that "Fortpflanzungsorgane unbekannt" * was the most that had been said of the mode of reproduction in this genus *Avrainvillea*, which had been recognized since 1842, we proceeded to examine the newly found structures with much interest. The enlarged terminal portions of these filaments varied in form from clavate and fusiform to pyriform or subglobose and they had the appearance of being stipitate, being raised above the general surface once or twice their own length by a scarcely modified part of the filament. The younger and smaller as well as some of the larger of these peculiar bodies were intensely green, contrasting notably with the dingy-fuscous tint of the plant in general, but many of the older and larger had turned brown, the color residing partly in the filament wall and partly in the contents and being evidently an intensification of the color characteristic of the ordinary vegetative condition of the species. After a microscopic examination, the plant was placed in a jar of seawater with the hope that on the following morning living zoöspores might be seen to emerge from the suspected sporangia. But our hopes were disappointed. Then, as on the previous evening, many of the supposed sporangia contained usually from three to five (one to eight) ovoid, pyriform, elongate-ellipsoidal, or difform bodies, occupying together one-half or more of the cavity of the enlargement. Impressed by the evident lack of homology with what little is known of reproduction in other members of the *Codiaceae*, we suspected that these peculiar interior bodies might be endophytic parasites of some sort and that the sporangium-like swellings might be simply galls caused by their presence, and so, with the conviction that the *Avrainvillea* was by this time dead, we added formalin to the seawater to preserve the interesting specimen for further study at some more convenient time. Subsequent investigations have succeeded in bringing to light practically all stages in the development of the sporangium-like organs, including great numbers of withered and empty ones, and nothing has been discovered to indicate that the more or less spore-like bodies are anything other than normal parts of the *Avrainvillea* itself; they certainly contain chlorophyl and starch and the chloroplasts appear to be of the same character as those of the ordinary filaments of the thallus. Indeed, the supposed sporangia occur in too great profusion, even though on a single plant, and they are too regular in form and position, we believe, to be anything else than normal.

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* Wille; Engler & Prantl, Nat. Pflanzenfam. $1^2$: 141. 1890.

The sporangia are always terminal on branches, which, except for the presence of the sporangium, are but slightly different from the ordinary vegetative filaments of the flabellum, being, however, less moniliform or torulose, and often more slender than the filament from which they spring. These sporangiophores result from the ordinary forking of the filaments and they are commonly homologous with a vegetative branch which would undergo two or three more dichotomies (FIGURE 15). Some which can be traced back to the deeper-lying filaments are falsely lateral in origin. The form of the sporangia has been alluded to above, but the figures published herewith give a more accurate idea of their character. They vary from 0.35 to 0.83 mm. in length and from 0.20 to 0.35 mm. in width. Sometimes, as shown in FIGURES 22 to 24, the base of the sporangium, underneath the spores, is occupied by a brownish mass of slime or mucilage, forming a more or less complete basal septum. The plug, however, is perhaps more commonly near the base of the sporangiophore, as shown in FIGURE 15. Occasionally, as in FIGURE 13, the stoppage is near the middle of the sporangiophore. Often, two such plugs may be found, one at the base of the sporangium and the other at the base of the sporangiophore. The brown callose-mucilage evidently furnishes the material for healing the wound caused by the withering away of the empty sporangium. Numerous brown, rounded, thick-walled, stump-like processes, like that shown in FIGURE 20, may be found, indicating the position of former sporangiophores. It rarely happens that practically the whole protoplast of the sporangium is consumed in the formation of a single spore, but the usual number is three, four, or five, as stated above, though occasionally as many as six, seven, or eight are formed. The spores are most commonly long-ovoid or pyriform and as they lie in the sporangium the broader end is usually upward. They are densely crowded with chloroplasts and starch-grains but as they mature the amount of starch appears to increase at the expense of the chlorophyl. Some of the spores show a pronounced polarity, or perhaps it may be called a beginning of germination, while still in the sporangium. Thus, in the second spore from the right in FIGURE 21, the foot or base of the young plant is plainly manifest. Such basal parts have less chlorophyl and starch than the remainder of the spore. The membrane enclosing the spore is usually thin and delicate and often scarcely demonstrable. When the spores are well formed, there is a peculiar aggregation of granules at the apex of the sporangium (FIGURES 21, 24) and this appears to be followed soon by the rupturing of the sporangium wall in this region, forming a rather wide irregular opening. All the spores in any single sporangium seem to be discharged at about the same time, for the sporangia as found, with a few possible exceptions, are either empty or contain their full complement of spores. Very little is known of the history of the spores on leaving the sporangium. FIGURE 19 shows a spore which had been caught at the mouth of the sporangium and had evidently begun its extra-sporangial growth, forming an evident foot and the first "bead" of a moniliform filament; this was firm-walled and very brown.

The large size of the spores (130–300 $\mu \times$ 66–120 $\mu$), their heavy load of starch, and their occasional development of an evident foot while still in the sporangium, make it practically certain, in our opinion, that these bodies are not self-motile, *i. e.*, that they are *aplanospores*. Yet, the thinness of the surrounding membrane and the fact that none of the bodies has thus far been found germinating on the surface of the thallus (if we except the captured one shown in FIGURE 19) have suggested the possibility of their being synzoöspores. However, it is much more probable that we have to do with aplanospores, perhaps analogous to those which occur in smaller size and larger number in *Gomontia polyrhiza* (Lagerh.) Born. & Flah. or to those which have been described as occurring singly in *Vaucheria hamata* and *V. geminata*.*

## E. ON THE AMERICAN SPECIES OF AVRAINVILLEA

In a former paper † we alluded to some of the difficulties in the way of distinguishing species in the genus *Avrainvillea* and commented on the characters of the original specimens of *Avrainvillea nigricans* Decaisne and *Rhipilia longicaulis* Kütz. Since that time we have enjoyed the opportunity of seeing again living plants of this genus in Porto Rico and in Jamaica, and have arrived at conclusions that are, to us, more satisfactory as to the number of species that are represented in the West Indian waters, in so far as one may judge of the matter from the material now at hand. We therefore venture to give below a diagnosis of the genus, a key to the American species, and a synoptical account of the four species that we recognize.

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* Waltz, J. Jahrb. Wiss. Bot. **5**: 132, 133. 1866.

† Bull. Torrey Club **32**: 565–568, 586. 1905.

AVRAINVILLEA Decaisne, Ann. Sci. Nat. II. **18**: 108. 1842

*Fradelia* Chauvin, Recherches 124. 1842.

*Chloroplegma* Zanard. Mem. R. Ist. Ven. **7**: 290. 1858.

Thallus fusco-nigrescent, tawny-green, or olivaceous, usually flabelliform and stipitate, more rarely difform or irregularly digitate, destitute of calcareous incrustation, composed of dichotomous interwoven cylindrical, torulose, or moniliform threads, these nearly similar throughout, being without specialized corticating branches and without fibular processes. Stipe, when differentiated, simple or sometimes forked, terete or flattened. Flabellum suborbicular, reniform-cordate, or cuneiform, or (in *A. Rawsoni*) deficient, rarely zonate. Rhizoids in an irregularly bulbous mass or sometimes forming a rhizome. Sporangia (known only in *A. nigricans*) terminal on filaments exserted from surface of flabellum, containing a few (1–8) spores (aplanospores?). All species marine.

Type species, *Avrainvillea nigricans* Decaisne.

### Key to the American species

Thallus eventually developing a flabellum (usually stipitate).
  Fusco-nigrescent or tawny-green; surface subvelutinous, minutely spongiose, or strigose: filaments of flabellum 28–70 μ in diameter.
    Filaments of flabellum moniliform. 1. *A. nigricans.*
    Filaments of flabellum cylindrical with a strong constriction at base of each branch, rarely subtorulose. 2. *A. longicaulis.*
  Olivaceous or cinereous; surface smooth and compact; filaments of surface of flabellum 6–24μ in diameter. 4. *A. levis.*
Thallus not developing a flabellum, forming more or less digitate, sometimes capitate lobes, these commonly very irregular in form, and often branching, diffluent, or anastomosing. 3. *A. Rawsoni.*

1. AVRAINVILLEA NIGRICANS Descaisne, Ann. Sci. Nat. II. 18: 1842.— M. A. Howe, Bull. Torrey Club **32**: 567, 568. 1905.

*Fradelia fuliginosa* Chauvin, Recherches 124. 1842.

*Avrainvillea longicaulis* Murr. & Boodle, *p. p.* Jour. Bot. **27**: 70. *pl. 228. f. 1–5.* 1889. (Excluding syn. *Rhipilia longicaulis* Kütz.)

Usually fusco-nigrescent when living or rarely tawny-green, of a similar color on drying or somewhat darker or more sordid, gregarious or scattered, normally with a stout horizontal rhizome (commonly left in substratum as ordinarily collected), or, when small and poorly developed, with a somewhat bulbous or difform base: stipe cylindrical or flattened, 1–16 cm. long, 3–14 mm. wide, now and then deficient or scarcely differentiated, simple or rarely forked near the base: flabellum varying from suborbicular (reniform-cordate when young) to cuneiform (sometimes subclavate when young), 1–25 cm. broad, entire or more or less lacerately or digitately lobed, thin and membranous in the broader forms, thicker and more coriaceous in the narrower, felt-like in texture, very obscurely or not at all zonate, the surface subvelutinous or minutely spongiose: filaments of flabellum distinctly moniliform or torulose (at least those near the surface) usually firm-walled and rather straight and rigid, 33–70 $\mu$ in maximum diameter, filaments of stipe similar, but with more differentiation between those of surface and those of interior: sporangia mostly subpyriform, varying from clavate to subglobose, 0.35–0.83 mm. × 0.20–0.35 mm., usually exserted once or twice their own length; spores ovoid, pyriform, or elongate-ellipsoidal, 130–300 $\mu$ × 66–120 $\mu$.

TYPE LOCALITY: Iles des Saintes, near Guadeloupe, West Indies; type specimen in the herbarium of the Muséum d'Histoire Naturelle in Paris.

DISTRIBUTION: Bermuda, southern Florida, the West Indies, and South America.

*Avrainvillea nigricans*, as here conceived, is widely variable in form and size, though tolerably uniform in the character of its filaments. Further remarks by the writer on its range of variation may be found in the place cited above.

2. AVRAINVILLEA LONGICAULIS (Kütz.) Murr. & Boodle, *p.p.* Jour. Bot. **27**: 70. 1889. (Excluding all but syn. *Rhipilia longicaulis* Kütz., which may be fairly considered the "type" of the new binomial.)

*Rhipilia longicaulis* Kütz.* Tab. Phyc. 8: 13. *pl. 28. f. II.* 1858.

*Avrainvillea Mazei* Murr. & Boodle, *l. c. pl. 288. f. 6.*

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*M. A. Howe, Bull. Torrey Club **32**: 586. 1905.

Fusco-nigrescent or sometimes sordid- or tawny-green when living, of a similar color on drying, gregarious or scattered, with or without a horizontal rhizome: stipe flattened or subterete, 1–15 cm. long, 3–10 mm. wide, rarely deficient, simple or forking near the base: flabellum cuneate obovate, oblong, or sometimes suborbicular, now and then diffuse, imperfectly complanate, and irregularly lobed, 1–12 cm. broad, coriaceous in the smaller forms, thinner and of looser texture in the larger, most obscurely or not at all zonate, the surface strigose, subvelutinous, or minutely spongiose: filaments of flabellum cylindrical, strongly constricted just above the dichotomy, rarely here and there subtorulose, usually firm-walled and mostly rather straight and rigid, 28–70 $\mu$ in diameter; filaments of surface of stipe commonly more slender, interwoven, rhizoid-like, those of interior sometimes crowded with amylum grains.

TYPE LOCALITY: "Ad Antillas" [Antigua]; type specimen in the Sonder collection of the National Herbarium of Victoria, Australia.

DISTRIBUTION: Bermuda and the West Indies.

The maintenance of the binomial *Avrainvillea longicaulis* for the present species and the crediting of the name to Murray & Boodle are both, we believe, technically correct, even though it may prove a source of some confusion for a time, inasmuch as Murray & Boodle evidently intended that another species — the true *A. nigricans* Decaisne — should bear Kützing's name *longicaulis*. But, as Murray & Boodle in proposing the new combination *Avrainvillea longicaulis* cited Kützing's *Rhipilia longicaulis*, it cannot be denied that this new combination applies also to Kützing's species and that it applies to it in a peculiar and typical way. Notes by the present writer on Kützing's type-specimen have been published in the place cited above and in the same paper also (pages 567, 568) are comments on the relationship of the present species to *A. nigricans*. *A. longicaulis* and *A. nigricans* often grow intermingled and resembling each other so closely that they cannot be determined without a microscopical examination, yet the more that we see of them the more we are inclined to the belief that they represent true species.

### 3. **Avrainvillea Rawsoni** (Dickie)

*Rhipilia Rawsoni* Dickie, Jour. Linn. Soc. **14**: 151. *pl. 11. f. 1, 2.* 1874.

*Avrainvillea nigricans* Murr. & Boodle, *p.p.* Jour. Bot. 27 : 70. 1889. Not *A. nigricans* Decaisne.

Mostly bright- or sordid-green when living, becoming fuscous-brown or nigrescent on drying, forming cespitose masses with usually crowded, subterete, fusiform, clavate, or finger-shaped, sometimes capitate, often difform, branched, and anastomosing lobes, never developing a flabellum ; lobes azonate, mostly 4–12 cm. long and 0.5–4.0 cm. in diameter, now and then disappearing in irregular cushions by fusing, the surface velutinous, spongiose, or substrigose : filaments of the lobes subtorulose or the inner cylindrical with occasional constrictions, always strongly constricted just above the dichotomy, rather thin-walled and somewhat easily collapsible, 28–68 $\mu$ in diameter. [PLATE 30.]

TYPE LOCALITY : Barbados ; type in the herbarium of the British Museum.

DISTRIBUTION : The West Indies.

Apparently common in the West Indies, ranging at least from the northern Bahamas to Jamaica and Porto Rico, growing from low-water mark down to a depth of one meter, often on exposed rocks near the low-water line. The species is represented in the herbarium of the New York Botanical Garden at the present time by specimens under seventeen collection numbers. *No. 770* of the Phycotheca Boreali-Americana of Collins, Holden, and Setchell, issued as *Avrainvillea longicaulis* (Kütz.) Murr. & Bood., and *no. 771* of the same series, issued as *Avrainvillea nigricans* Decaisne, both collected at Montego Bay, Jamaica, by Mrs. C. E. Pease and Miss E. Butler, belong with the present species, at least in the three sets examined, though in one set, the material issued under no. 770 is mixed with *A. nigricans ;* however, all three of the species named are found at Montego Bay. *Avrainvillea Rawsoni* is the plant that we once* referred to as "what we believe to be a low-littoral or shallow-water condition of *Avrainvillea Mazei*," but since we have seen it growing profusely in deeper water in Jamaica closely associated with both *A. longicaulis* (*A. Mazei*) and *A. nigricans* and without showing the least tendency to intergrade with either, we cannot do otherwise than consider it abundantly entitled to specific rank. The plant evidently never develops a true flabellum and the filaments are thinner-walled, more collapsible and more torulose than is ordinarily the case in the true *A. longicaulis* (*A. Mazei*) and they are thinner-walled and less moniliform than in *A. nigricans*. The specimen selected for our photograph (PL. 30) represents a common form of the species, though its lobes are narrower, more clavate or subfusiform than those of the plant originally described and figured by Dickie.

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* Bull. Torrey Club 32 : 568. 1905.

4. AVRAINVILLEA LEVIS M. A. Howe, Bull. Torrey Club **32**: 565. *pl. 23. f. 1; pl. 26. f. 8–10.* 1905

*Avrainvillea sordida* Murr. & Boodle, Jour. Bot. **27**: 70. 1889. Not *Avrainvillea sordida* (Mont.) Crouan; * Mazé & Schramm, Essai Alg. Guad. 89. 1870–'77.

TYPE LOCALITY: Cave Cays, Exuma Chain, Bahamas.

DISTRIBUTION: Bahamas; Jamaica; Guadeloupe; Grenada (*fide* Murray & Boodle).

### SPECIES EXCLUDENDAE

After examining authentic specimens, we agree with Murray & Boodle † in referring *Rhipilia tomentosa* Kütz. to *Udotea* and in identifying with it *Avrainvillea laetevirens* Crouan. However, the characters of this species seem to make the line of separation between the genera *Avrainvillea* and *Udotea* an almost arbitrary one. Outside of the possession of occasional attachment organs by the filaments — so little abundant that they were overlooked by Kützing — the species has more in common with *Avrainvillea* than with *Udotea*, bearing, in fact, a close external resemblance to certain conditions of *A. longicaulis*. Our *no. 3209*, from North Cat Cay, Bahamas, evidently belongs with *Udotea tomentosa*. ‡

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* For a discussion of the technical application of this name, see Bull. Torrey Club **32**: 566. 1905.

† Jour. Bot. **27**: 72. 1889.

‡ UDOTEA TOMENTOSA (Kütz.) Murray, Jour. Bot. **27**: 239. 1889.

*Rhipilia tomentosa* Kütz. Tab. Phyc. **8**: 12. *pl. 28. f. 1.* 1858.

*Avrainvillea laetevirens* Crouan; Mazé & Schramm, Essai Alg. Guad. 89. 1870–77 (nomen seminudum).

Plants 3–6 cm. high, from a scarcely rhizomatous base, bright-green, fading to yellowish-albescent or isabelline, without calcareous incrustation; stipe subterete or flattened, 0.5–2 cm. long, 2–4 mm. wide, simple: flabellum cuneiform-obovate, obdeltoid, or oblong-cuneiform, 3–5 cm. long, 1–3.5 cm. broad, entire, 2–4-lobed, or at length irregularly lacerate, very obscurely or not at all zonate, rather thick, uncorticated, spongiose in texture, surface spongiose tomentose, the stipe of similar appearance: filaments of flabellum thin-walled, imperfectly reviving on being soaked out, intricately intertangled, 35–70 μ in diameter, cylindrical or irregularly inflated here and there especially at apices, usually a little constricted just above a dichotomy, the dichotomies often near together and the branches sometimes pseudolateral, many of the shorter branches (often apparently and perhaps truly lateral) terminating in 2–4 or more short small divaricate processes which serve as organs of attachment to adjacent filaments, thus forming more or less of a network; filaments of stipe similar but with greater diversity in size, those of interior 55–100 μ in diameter, those of surface often only 16–30 μ.

TYPE LOCALITY: Antigua, British West Indies; type specimen in the Sonder collection of the National Herbarium of Victoria, Australia.

DISTRIBUTION: Antigua; Guadeloupe; Bahamas.

We owe to Mr. J. R. Tovey, of the National Herbarium of Victoria, Australia, the privilege of examining a portion of the type material, including, evidently, the plants from which Kützing drew his figure *a′*.

A second West Indian species of somewhat doubtful generic position is the following:

UDOTEA LUTEOFUSCA (Crouan) Murray, Jour. Bot. **27**: 239. 1889 (nomen seminudum).

*Flabellaria luteofusca* Crouan; Mazé & Schramm, Essai Alg. Guad. 88. 1870–'77 (nomen seminudum).

Plants 4–10 cm. high, fuscous or dark yellowish-brown, uncalcified; stipe simple or 1–3 times dichotomous, flattened or subterete, 2–7 cm. long, 2–5 mm. wide, corticated: flabellum cuneate-obovate or irregularly semiorbicular with cuneate base, sometimes 4 or 5 flabella to a plant through forking of stipe, each 2–5 cm. long, 1–6 cm. wide, not at all or very obsoletely zonate, corticated, the surface smooth or longitudinally somewhat rugulose, the margins erose, lacerate, or irregularly lobed: filaments of the medulla yellowish or yellowish-brown, in several layers or towards the margins almost unistratose, being there commonly visible through the cortex and giving the plant a venulose appearance under a lens, 50–80 μ in diameter, cylindrical or slightly and irregularly constricted, their falsely lateral branches forming the intricate, labyrinthine cortex by repeated divaricate often somewhat zig-zag dichotomies, the ultimate branchlets of the corticating filaments 4–10 μ in diameter, decolorate.

TYPE LOCALITY: Lake Simpson, St. Martin, West Indies; type specimen *no. 1403* of the Mazé & Schramm collection in herb. Crouan (in herb. Bornet, Paris).

DISTRIBUTION: Known only from the type locality.

This interesting plant offers points of contact with the genera *Avrainvillea*, *Udotea*, and *Cladocephalus* (Bull. Torrey Club **32**: 569), but is perhaps most at home in *Udotea*, where Murray (*l. c.*) has doubtfully placed it. But we find no grounds for supposing with Murray that this "form" is an "imperfect state." In color and general habit it has most in common with *Avrainvillea*, but it is corticated; the general character of the cortex, however, is rather different from that of any other described species of *Udotea*, the corticating filaments being much more regularly dichotomous than in *Udotea Desfontainei* and without the ultimate lateral nodular excrescences or irregularly cristate-pectinate coherent branchlets of that species. In the nature of the cortex it closely resembles *Cladocephalus scoparius;* in fact, the species stands in much the same relation to *Cladocephalus* that *Udotea conglutinata* does to *Penicillus*, *Udotea conglutinata* being a *Penicillus* except in having a flabellum instead of a capitulum.

## Explanation of plates 25-30

### PLATE 25

1–10. *Halimeda Tuna*

1. Portion of a segment (decalcified), in radio-vertical section, showing peripheral utricles, utricles of the subcortical layer, and medullary filaments.

2 and 3. Peripheral utricles and utricles of the subcortical layer, decalcified and teased out; the peripheral utricles separating rather easily.

4. Peripheral utricles, decalcified, in surface view; no fusion is noticeable.

5. Vertical section by microtome through the filament of the central strand (decalcified) at a node; just above the points of fusion the filaments are somewhat enlarged and are inclined to cohere.

6. Two filaments from the central strand of a node, teased out, each formed by the fusion of two; just above the points of fusion there has been considerable coherence of the adjacent filaments and the outer layers of the filament-walls are more or less scarred and lacerated by the process of teasing the filaments apart.

7. A young simple sporangiophore.

8. A sporangiophore from the margin of a segment, formed by the fusion of three filaments of the central strand.

9. A forked sporangiophore from the margin of a segment, formed by the fusion of two filaments of the central strand.

10. The beginning of a sporangiophore at margin of segment. (For sporangiophores of a different origin, see Plate 28, Figures 1 and 2.)

Figures 1–10 are all drawn from formalin-preserved material of our *no. 4201* (Culebra Island, Porto Rico); 1–6 are magnified 40 diameters; 7–10, 24 diameters.

11–20. *Halimeda discoidea*

11. Portion of a segment (decalcified), in radio-vertical section, showing peripheral utricles of the subcortical layer, and medullary filaments.

12 and 13. Peripheral utricles and distal ends of the utricles of the subcortical layer, decalcified, showing contact of the peripheral utricles and their occasional interlocking.

14 and 15. Peripheral utricles, etc., showing fusion as well as interlocking.

16. Utricle of the subcortical layer bearing numerous peripheral utricles.

17. Peripheral utricles, decalcified, in surface view, showing fusions; fusions of two utricles are common; near the upper left-hand corner and a little below the middle, in the figure, are fusions of three utricles; near the lower left-hand corner is a fusion of four.

18. Peripheral utricles, decalcified, in surface view, the dotted lines indicating the form and position of the distal ends of the utricles of the subcortical layer, which are often clearly visible through the peripheral utricles.

19. Filaments from central strand of nodes, showing incomplete fusion.

20. Filament from central strand of node, showing complete fusion of two filaments to form one, which afterwards divides into three. The filaments shown in Figures 19 and 20 are from the same node.

Figures 11–20 are all drawn from formalin-preserved material of our *no. 2964* (Caesar's Creek, Florida); 11, 16–20 are magnified 40 diameters; 12–15, 55 diameters.

### PLATE 26. *Halimeda discoidea*

Photograph of a formalin-preserved specimen from Caesar's Creek, Florida (*no. 2964*, 31 Mr 1904), natural size.

### PLATE 27

1. *Halimeda tridens.* Photograph of a formalin-preserved fertile specimen from Tallaboa, Porto Rico (*no. 4424*, 22 Mr 1906), natural size.

2–4. *Halimeda Tuna.* Photograph of formalin-preserved fertile specimens from Culebra Island, Porto Rico (*no. 4201*, 3 Mr 1906), natural size.

### PLATE 28

#### 1 and 2. *Halimeda Tuna*

1 and 2. Sporangiophores of apparently lateral origin from the central filaments and formed without fusion; these were from the flattened face of a segment.

The figures are drawn from formalin-preserved material of our *no. 4201* (Culebra Island, Porto Rico); the magnification is 24 diameters.

#### 3–7. *Halimeda tridens*

3. A cluster of three sporangiophores from the margin of a segment; each is a continuation of a filament of the central strand coherent with the adjacent filaments near the point of emergence and anastomosing with them.

4. A sporangiophore from the flattened face of a segment; this is a direct continuation of a utricle (distal series) of the subcortical layer.

5. Base of sporangiophore of origin similar to that shown in Figure 4.

6 and 7. Bases of sporangiophores from the flattened faces of segments; these are direct continuations of the peripheral utricles; in Figure 6 the sporangiophore forks at the base, perhaps abortively.

Figures 3–7 are drawn from formalin-preserved material of our *no. 4424* (Tallaboa, Porto Rico); all are magnified 24 diameters.

#### 8–26. *Avrainvillea nigricans*

8. Portion of surface of the flabellum, with exserted sporangia.

9–13. Young sporangia in various stages of development. Near the middle of the stipe in Figure 13 is indicated the position of the mucous or callose plug.

14. A sporangium which has aborted and resumed vegetative growth.

15. A nearly mature sporangium; the figure shows the mucous plug near the base of the stipe and the usual relation of the sporangiophore to the vegetative filaments.

16. A young sporangium paired with an old and empty one.

17. A sporangium with spores nearly formed.

18. A pair of empty and shriveled sporangia, showing the wide erose or lacerate opening at the apex of each and the mucous or callose thickening at the base of the sporangiophore.

19. A spore adhering to the mouth of an empty sporangium, where it has begun its extra-sporangial development.

20. A healed-over "stump" left by the decay of an old sporangiophore.

21. A mature sporangium with four spores. A collection of granules at the apex seems to indicate the area of the future rupture of the sporangium-wall.

22. A mature sporangium with four spores; the base of the sporangium is nearly filled and closed by brown mucus.

23. A sporangium open at apex, although the enclosed spores are still imperfectly outlined.

24. A mature sporangium with three spores; a mucous plug in the base of the sporangium and a collection of granules at its apex.

25. A large sporangium containing four spores clearly outlined and three or more others imperfectly formed.

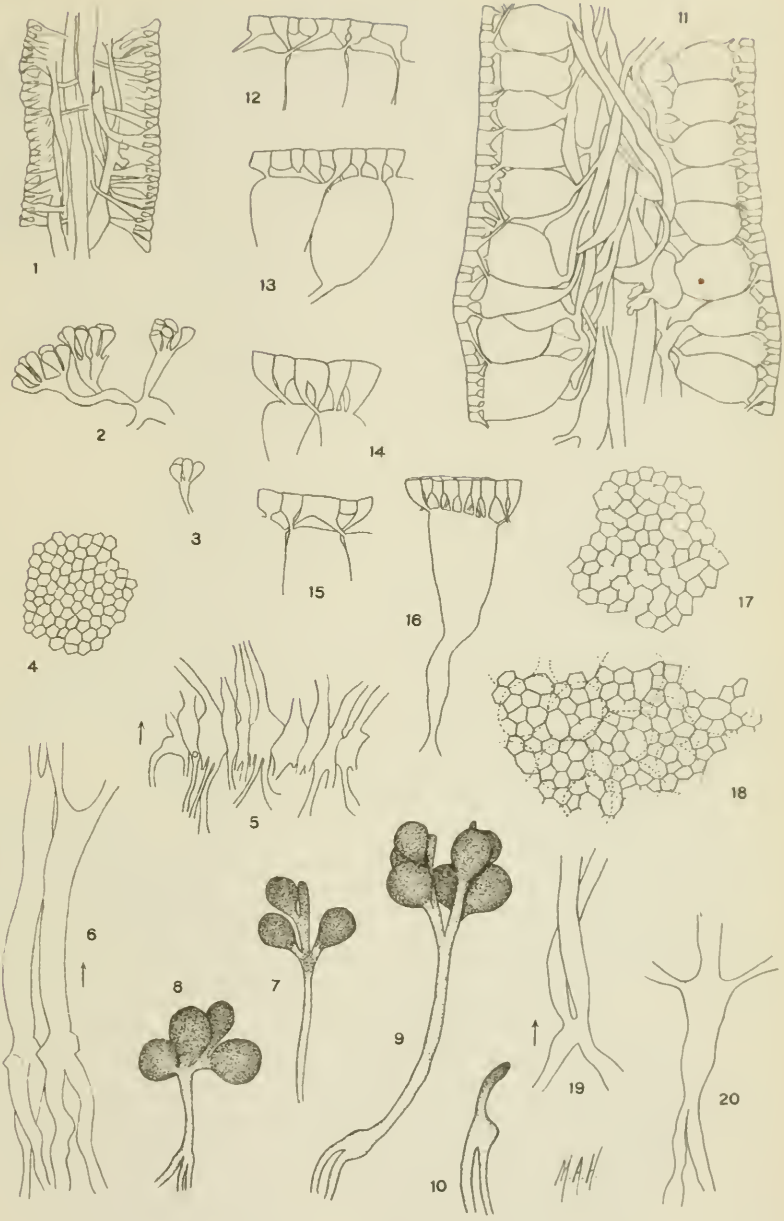
Figures 8–25 are all drawn from formalin-preserved material of our *no. 4794* (Montego Bay, Jamaica); 8 is magnified 12 diameters; 9–19, 24 diameters; 20–25, 52 diameters.

### PLATE 29. *Halimeda simulans*

Photograph of a dried specimen (*no. 4332*, type — Culebra Island, Porto Rico, 6 Mr 1906, M.A.H.), natural size.

### PLATE 30. *Avrainvillea Rawsoni*

Photograph of formalin-preserved specimen in water (*no. 4843*, Montego Bay, Jamaica), natural size.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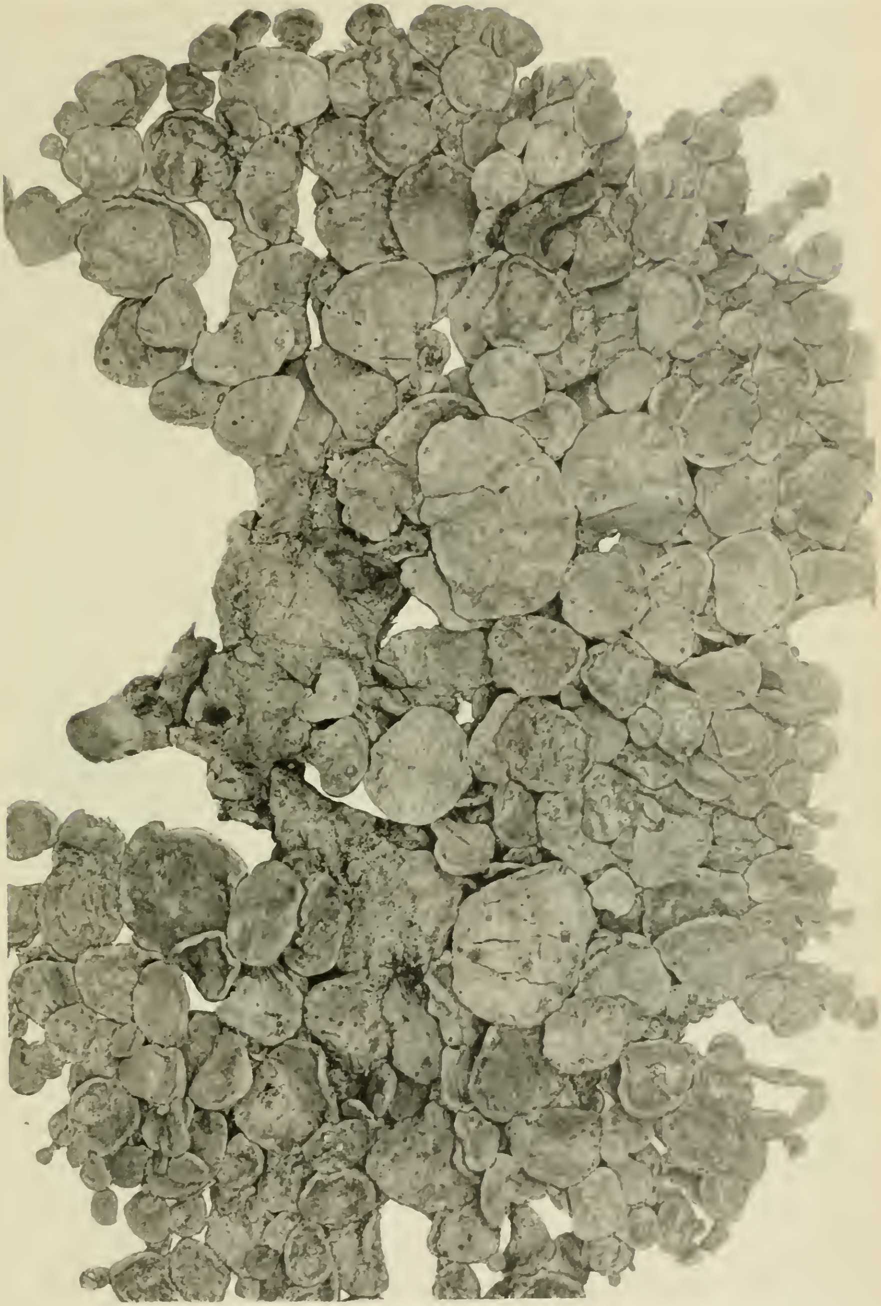
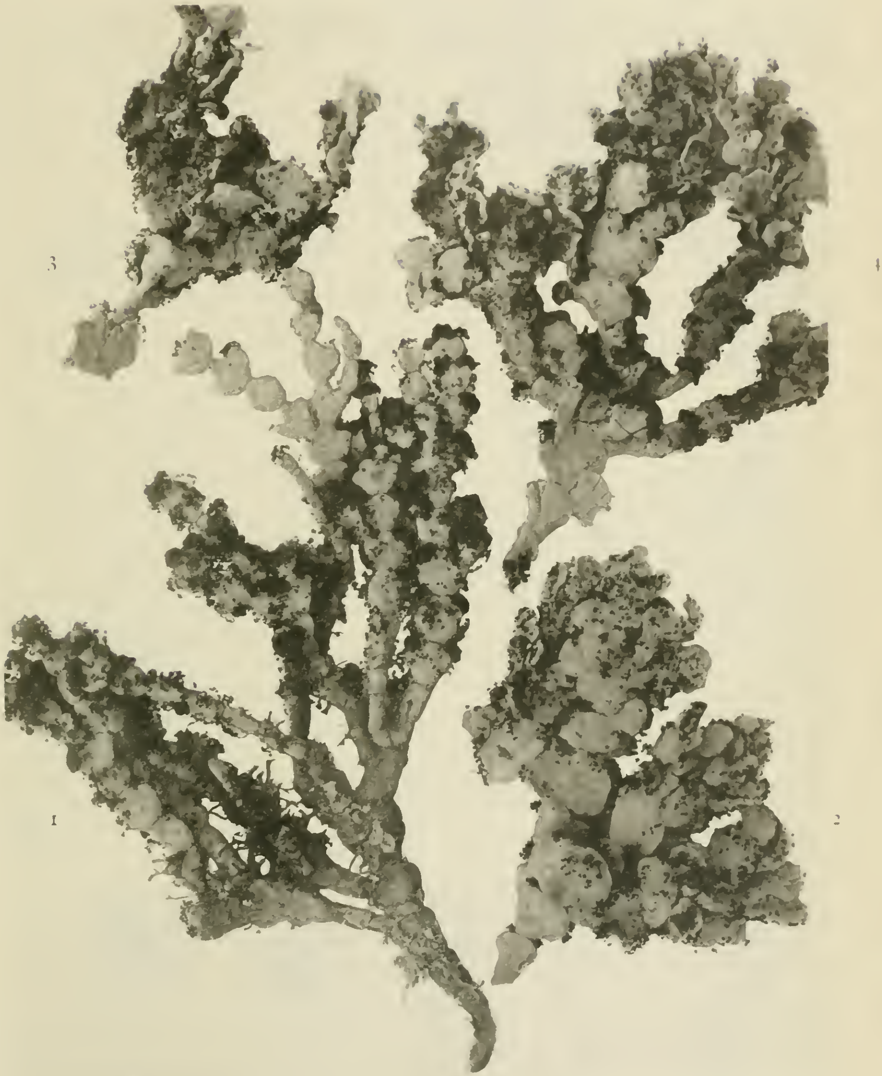
1-10 HALIMEDA TUNA (Ell & Soland) Lamour.

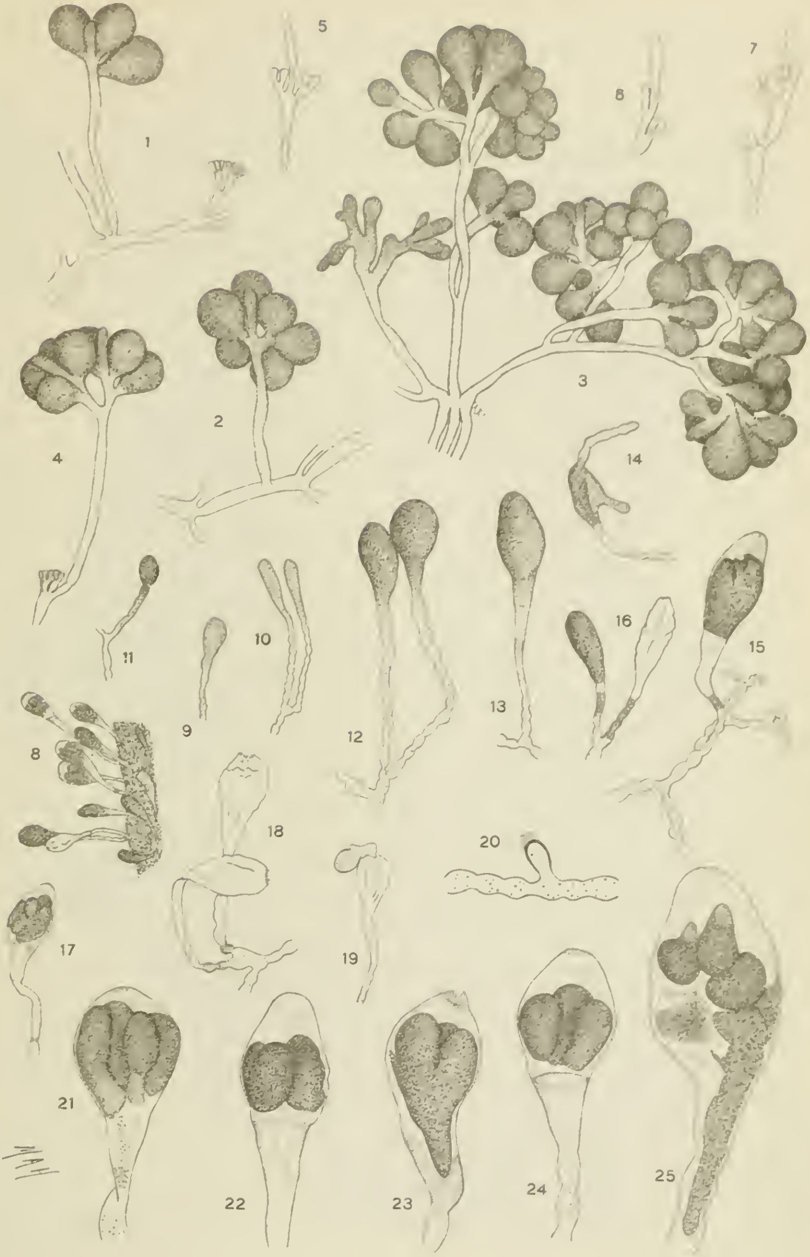
11-20 HALIMEDA DISCOIDEA Decaisne.



HALIMEDA DISCOIDEA Decaisne



1. HALIMEDA TRIDENS (Ell. & Soland.) Lamour.
2-4. HALIMEDA TUNA (Ell. & Soland.) Lamour.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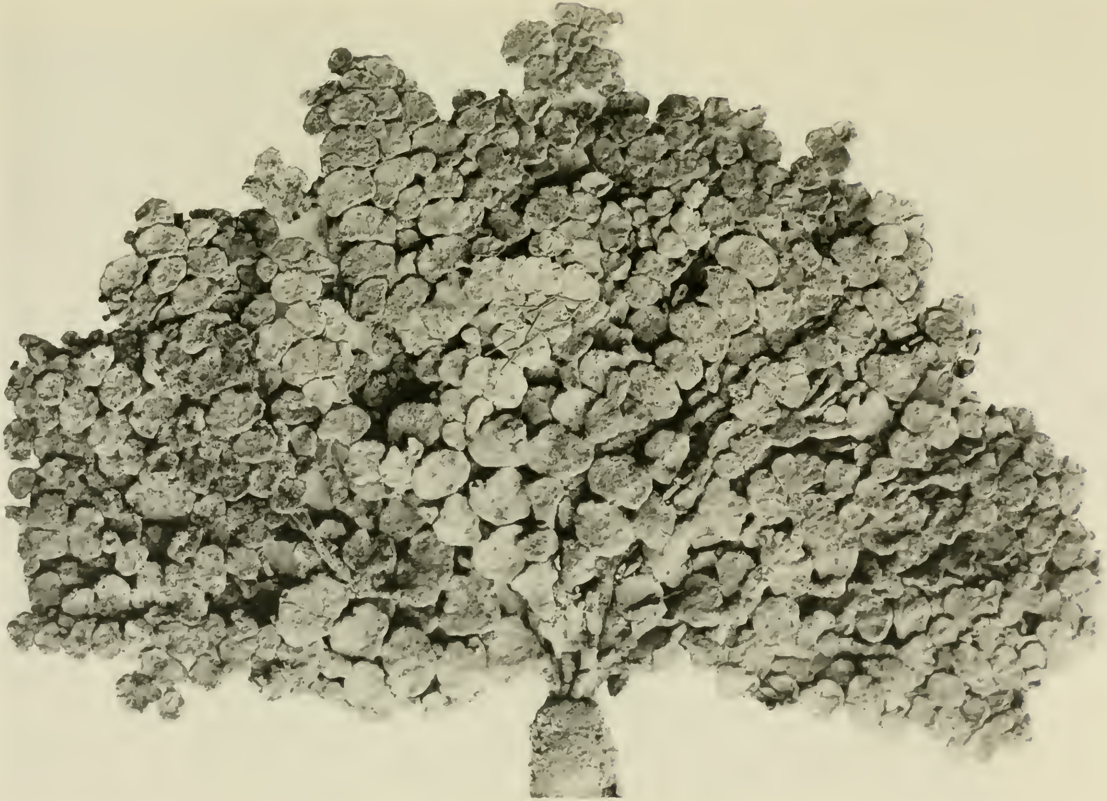
1 and 2 HALIMEDA TUNA (Ell. & Soland) Lamour.
3-7 HALIMEDA TRIDENS (Ell & Soland) Lamour.
8-25 AVRAINVILLEA NIGRICANS Decaisne.



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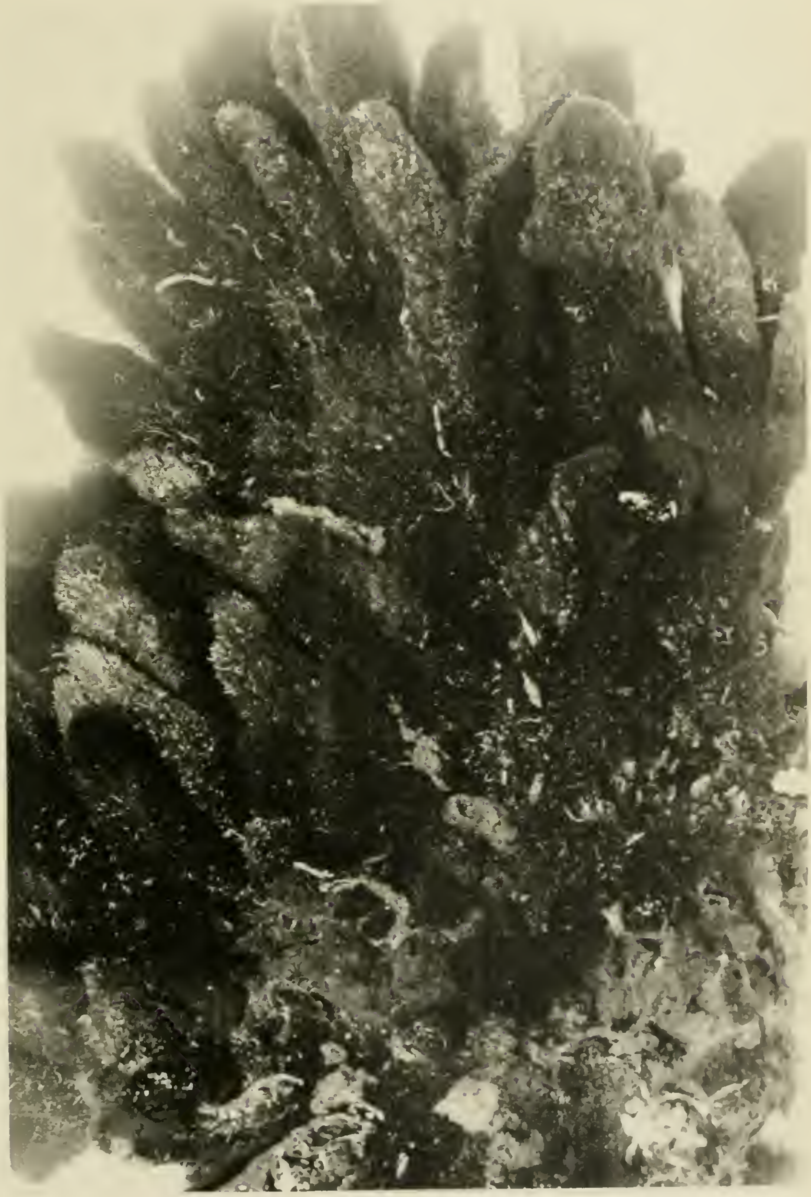
HALIMEDA SIMULANS M.A.Howe.



AVRAINVILLEA RAWSONI (Dickie) M. A. Howe.

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# MOSSES FROM TROPICAL AMERICA

By ROBERT STATHAM WILLIAMS

NEW YORK
1908

[From the BULLETIN OF THE TORREY BOTANICAL CLUB 35: 569-574. 1908]

[From the Bulletin of the Torrey Botanical Club, 34: 569–574. 1907]

# Mosses from tropical America

Robert Statham Williams

## COLOMBIAN MOSSES COLLECTED BY H. PITTIER

Sphagnum medium purpurascens (Russ.) Warnst.

Paramo de Buena Vista, 3000–3600 meters, January, 1906 (*1138*).

Dicranella Perrottetii (Mont.) Mitt.

Cordoba, Dagua Valley, 30–100 meters, December, 1905 (*551*).

Dicranum frigidum C. M.

Paramo de Moras, between Mozoco and Pitayo, 3000–3500 meters, February, 1906 (*1387*).

Dicranum speciosum Hook. f. & Wils.

Paramo de Buena Vista, 3000–3600 meters, January, 1906 (*1206*).

Campylopus concolor (Hook.) Mitt.

Around Huila, Rio Paez Valley, 1600–1900 meters, January, 1906 (*1271*).

### **Campylopus** (*Pseudocampylopus*) **Pittieri** sp. nov.

Inflorescence not determined: plants in dense, rather light-green tufts about 1 cm. high, with short, appressed branches and leaves densely imbricated and erect when dry; stem-leaves up to 5 mm. long, tubulose above, gradually narrowed to the denticulate apex formed by the excurrent nerve; costa 4 mm. wide at base, occupying about five-sevenths of the width of leaf-base, in cross-section showing a single row of large cells on upper surface and below about two rows of small, scarcely thicker-walled cells; cells of leaf-blade below, narrowly linear, pale, thin-walled, in about 6 rows, above becoming short and slightly obliquely elongated; perichaetial leaves up to 7 mm. long, convolute below, rather gradually narrowed to a slightly rough, subulate point longer than the sheathing part; seta smooth, 14 mm. long, sinuous above when dry, strongly curved when moist; capsule without stomata, oval, 2 mm. long without lid, dark-red just below mouth, deeply furrowed when dry, the beaked lid about two-thirds length of capsule; calyptra smooth, fimbriate at base; spores rough, up to 16 $\mu$.

Headwaters of Rio Lopez, Rio Palo basin, 2500–3000 meters January 24, 1906, H. Pittier (*1088*).

### **Dicranodontium setosum** sp. nov.

Dioicous: antheridia 0.5 mm. long with paraphyses slightly exceeding them: plants in yellowish-brown, glossy tufts with stems more or less branching at the base and 5 or 6 mm. high (perhaps only young plants); upper stem-leaves up to 11 mm. long, mostly erect-spreading, sometimes slightly curved and secund, gradually narrowed from a broad, not auriculate base, to a setaceous point, sharply denticulate 2 or 3 mm. down from apex and formed by the excurrent costa; costa reddish at base, in cross-section one half up showing one row of large cells on upper side with a narrow band of small, thick-walled cells beneath; leaf-cells above, elongated, more or less rectangular, in margin below narrowly linear, forming a somewhat distinct border, becoming wider toward the costa, and across leaf-base wide and hyaline, forming a more or less distinct group; perichaetial leaves, about the length of upper stem-leaves, with ovate-oblong, sheathing base rather abruptly narrowed to a rough subula about the length of sheathing part; seta erect, twisted above, up to 2 cm. long; capsule, without stomata and annulus, erect, oblong, smooth, without lid 1.75 mm. long, with a slightly obliquely rostrate lid nearly as long; peristome red, split three fourths down or more into slender, terete segments, obliquely striate on outer surface below and papillose above and on inner surface; calyptra entire at base, smooth above; spores slightly rough, up to 18 $\mu$ in diameter.

Paramo de Buena Vista, on tree-trunks, 3100 meters, January, 1906, H. Pittier (*2060*).

OCTOBLEPHARUM ALBIDUM (L.) Hedw.

Cordoba, Dagua Valley, 30–100 meters, December, 1905 (*552*).

FUNARIA HYGROMETRICA (L.) Sibth.

Hills of Miraflores above Palmira (*865*, *2063*).

FUNARIA CALVESCENS Schwaegr.

Immature specimens apparently of this species from the locality of preceding species.

BRYUM ARGENTEUM L.

Collected at various localities from 1500 to 3600 meters. (*777*, *1089*, *2061*, *2064*).

BRYUM sp.

Cuesta de Yocotá, 1500-1900 meters, December, 1905 (*778*). A small amount of some *Eubryum*, scarcely sufficient for determination.

RHIZOGONIUM SPINIFORME (L). Bruch.

Around San Andres de la Sierra, 1100-1300 meters, June, 1906 (*2068*).

POLYTRICHADELPHUS CILIATUS (Hook. f. & Wils.) Mitt.

Las Escaleretas, Moras Valley, 2500–3000 meters, February, 1906 (*1377*).

POGONATUM TORTILE (Sw.) Beauv.

Around San Andrés de la Sierra, 1100–1300 meters, June, 1906 (*2073*).

HOOKERIOPSIS GRACILIS (Mitt.) Jaeg.

Around San Andrés de la Sierra, 1100–1300 meters, June, 1906 (*2067*). The roughness of the seta of this species is often so slight just under the capsule as to be scarcely noticeable; the calyptra is not very rough above, and the double-pointed teeth of the leaf-margin are usually quite small.

?SEMATOPHYLLUM SUBSIMPLEX (Hedw.) Mitt.

Around San Andrés de la Sierra, 1100–1300 meters, June, 1906 (*2066*). But a very small amount of this specimen seen and possibly to be referred elsewhere.

MICROTHAMNIUM REPTANS (Sw.) Mitt.

Around San Andrés de la Sierra, 1100–1300 meters, June, 1906 (*2071*).

MICROTHAMNIUM TÜRCKHEIMI C. M.

Paramo de Buena Vista, 3000–3600 meters, January, 1906 (*1190*).

RHYNCHOSTEGIUM CONCHOPHYLLUM (Tayl.) Jaeg.

Headwaters of Rio Lopez, Rio Palo basin, 2500–3000 meters, January, 1906 (*1087*).

## GUATEMALAN MOSSES COLLECTED BY H. PITTIER

TIMMIELLA SUBANOMALA (Besch.) Broth.

Volcan de Agua, 1800–3400 meters, March, 1905 (*9*).

### **Leptodontium perannulatum** sp. nov.

Dioicous: ♂ plant slender with bud-like flowers a little over 1 mm. high, the antheridia 0.8 mm. long with rather abundant paraphyses; antheridial leaves costate, smooth, entire, ovate, acutely short-pointed: fertile plants in rather compact tufts with usually slightly branching stems up to 8 cm. high, dark-brown below, yellowish toward apex and with radicles mostly inconspicuous; stem-leaves more or less twisted-carinate, spreading or recurved when dry, recurved from near base when moist, up to 3.5 mm. long, oblong-lanceolate, recurved on the margin below, gradually narrowed to an acute, irregularly serrulate apex with costa nearly percurrent; cross-section of costa showing about 4 large cells with stereid bands of about one row of cells above and two rows below; cells of leaf-base yellow, linear, smooth with sinuously thickened lateral walls, cells above papillose, mostly irregularly oblong with much thickened walls, the median cells about 6 μ by 10 μ; perichaetial leaves up to 10 mm. long, smooth, costate to near apex, sheathing over one half up, gradually narrowed to a flexuous, distantly serrulate apex: pedicel 1 cm. high; capsule ovate-cylindrical, slightly curved and nodding, small-mouthed, 3 mm. long with a stoutly-beaked lid 0.8 mm. long; peristome-teeth lanceolate, 0.2 mm. long, pale golden-brown, glabrous, articulations often indistinct, more or less irregularly split longitudinally; annulus broad persistent, 7 or 8 rows of cells high, the upper rows of loosely cohering cells; spores rough, up to 22 μ in diameter.

Volcan de Agua, on sheltered rocks, 3400–3750 meters, March 22, 1905, H. Pittier (*42*). This species is near *L. brevisetum* Mitt., from which it may be distinguished by the leaf-cells. In *L. brevisetum* the median cells are smaller (mostly 5 μ by 5 to 6 μ) scarcely elongated or often slightly transversely elongated and with cell-walls thinner and straighter. In the Mitten herbarium a few fragments of this apparently undescribed species were found, evidently from the same locality as Pittier's specimens, but without date or collector, and were on the same sheet with *L. brevisetum.*

## CUBAN MOSSES COLLECTED BY W. R. MAXON

### **Holomitrium Maxoni** sp. nov.

Inflorescence not determined: plants in rather dark-green tufts with stems, bearing few branches, up to 8 mm. high: leaves, when dry, incurved-imbricated with margins above rolled in, when moist, more or less recurved and widely spreading, in outline nearly linear, up to 2.5 mm. long and 0.4 mm. wide, the apex mostly broadly rounded or somewhat truncate, with excurrent costa forming a stout apiculus and a few coarse, irregular teeth on either side; leaf-cells of upper leaf more or less hexagonal to oblong, about 12 μ wide and 20 to 40 μ long, gradually becoming longer and narrower toward base with cell-walls slightly thickened and pitted throughout; perichaetial leaves up to 7 mm. long, convolute below, gradually narrowed to a short-subulate, slightly serrulate apex formed by the excurrent nerve; pedicel up to 18 mm. long; capsule oblong-cylindrical, erect, 3 mm. long, red at the slightly contracted mouth; peristome-teeth attached about one fourth their length below the mouth, red below, strongly articulate, papillose on both sides and more or less divided along median line, either above or below, or sometimes throughout; spores nearly smooth, up to 12 μ in diameter; lid and calyptra not seen.

Posesion de Starck, Yateras, Oriente, 500 meters, May 3, 1897, W. R. Maxon (*4427*). Near *H. proliferum* and *H. Wrightii*, but without the flagellate branches of the first and with narrower, longer, thicker-walled basal cells, and differing from the second in the shorter, appressed leaves with more rounded point and teeth extending downward much less on either side.

SYRRHOPODON HOBSONI (Grev.) Mitt.

Monte Verde, Yateras, Oriente, 575 meters, April, 1907 (*4292*).

MACROMITRIUM HUSNOTI Schimp.

Monte Verde, Yateras, Oriente, 575 meters, April, 1907 (*4283*).

RHIZOGONIUM SPINIFORME (L.) Bruch.

Monte Verde, Yateras, Oriente, 575 meters, April, 1907 (*4310*).

ACROCRYPHAEA COFFEAE (C. M.) Par.

Jaguey, Yateras, Oriente, 420 meters, May, 1907 (*4347*).

NECKERA UNDULATA Hedw.

Valley of Rio Bayamita, on rock, 900–1050 meters, April, 1907 (*3977*).

ENTODON MACROPODUS (Hedw.) C. M.

Near Jaguey, Yateras, Oriente, 420 meters, May, 1907 (*4345*, *4359*): Farallones of La Perla, north of Jaguey, 540–585 meters (*4370*).

### **Cyclodictyon cubense** sp. nov.

Synoicous: plants forming low dull-green mats, the stems with complanate leaves 3 mm. wide; lateral leaves broadly ovate-oblong, up to 1.75 mm. long and 0.8 mm. wide, entire, acutely short-pointed with a pale border of one row of cells; median and upper leaf-cells hexagonal, slightly elongated, up to 50 μ long and about 40 μ wide, toward base becoming somewhat narrower and longer; costa forking at base, extending two thirds up, smooth on the back, apices not projecting; perichaetial leaves entire, short and ovate or ovate-lanceolate, with erect, acute apex, the longer about 1 mm. long; seta smooth, 12 mm. high; capsule nodding or pendant, about 1 mm. long, with a conical rostrate lid a little shorter; outer peristome-teeth red, cross-striate below, 65 μ wide at base, with median furrow 8 μ wide and reaching to near base from about two thirds up; inner segments solid, nearly as long as teeth, from a basilar membrane about one third height of teeth; spores smooth, 12 μ in diameter; calyptra smooth.

Finca Las Gracias, Yateras, Oriente, 500 meters, on decayed log, May 5, 1907, W. R. Maxon (*4495*). This species is near *C. limbatum* and *C. Regnellii*, but differs in the pale, entire border of leaf of only one row of cells and in the costa smooth on the back.

HAPLOCLADIUM MICROPHYLLUM (Sw.) Broth. (*Leskea microphylla* (Sw.) Mitt.)

Jaguey, Yateras, Oriente, at base of trees, 420 meters, May, 1907 (*4353*).

SEMATOPHYLLUM ADMISTUM (Sull.) Mitt.

Jaguey, Yateras, Oriente, 420 meters, May, 1907 (*4344*).

MICROTHAMNIUM THELISTEGUM (C. M.) Mitt.

Jaguey, Yateras, Oriente, 420 meters, May, 1907, (*4355*).

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# ALABASTRA PHILIPPINENSIA

By CHARLES BUDD ROBINSON

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# Alabastra philippinensia—I

Charles Budd Robinson

During the years 1903–1905 Mr. R. S. Williams made a very extensive collection of plants in the Philippine Islands on behalf of the New York Botanical Garden. At the time a high proportion of the species represented had not yet been described; but the indefatigable work of the American botanists in the islands has since brought the most of them to light through other sources. Many still remain unpublished, however, and the present paper is intended to call attention to some of these, and to add a few miscellaneous notes upon the flora of this interesting region. All types of newly described species are in the herbarium of the New York Botanical Garden.

## TAXACEAE

### Podocarpus latifolia Bl. Enum. Pl. Jav. 89. 1827

This name should be used instead of *P. Blumei* Endl. Syn. Conif. 208. 1847, which is its indubitable synonym. *P. latifolia* Bl. is generally discarded because of *P. latifolia* Wall., but the latter was published in Pl. As. Rar. **1**: 26. *pl. 30.* 1829, and this is antedated by Blume's species. *P. latifolia* R. Br.; Benn. Pl. Jav. Rar. 40. 1838, is a third and still later species.

*P. latifolia* Bl. is represented in this herbarium by the following Philippine numbers:

Northern Luzon: Province of Benguet, Baguio, *Williams 1035*.

Central Luzon: Province of Bataan, Lamao River, and Mt. Mariveles, *Williams 399, 624, 752, 753*; *Forestry Bureau* (coll. *Barnes*) *147, 194*; *Copeland 244*; *Whitford 1353*.

## TYPHACEAE

### Typha orientalis Presl, Epimel. Bot. 239. 1851

The type of this species is *Cuming 1767*, certainly from the Philippines, the locality assigned by Presl being the island of

Cebu; yet in the Pflanzenreich the Philippines are not included in its range, which is there given as northern China and Japan. Recent collections of this species are *Elmer 6382* and *8820*, both from Baguio, Province of Benguet, northern Luzon.

## PANDANACEAE

FREYCINETIA CUMINGIANA Gaud. Bot. Voy. Bonite *pl. 37. f. 12–14; pl. 60.* 1843, without description.

*F. luzonensis* Warb. in Engler, Pflanzenreich $4^9$: 35. 1900. *F. luzonensis* Presl, Epimel. Bot. 238. 1851, in part only.

Through the kindness of Prof. Wm. Trelease, I have been able to examine a specimen of *Cuming 1455*, belonging to the Bernhardi Herbarium of the Missouri Botanical Garden. It is upon this number that *F. luzonensis* was based and Presl's description makes it evident that it contained more than one species. Comparison of the above-mentioned specimen with the descriptions indicates that it is the true *F. luzonensis* Presl, and that the *F. luzonensis* of recent Philippine botany is quite distinct. It seems desirable therefore to take up for the latter Gaudichaud's older name, which has hitherto remained unused, because originally unaccompanied by verbal description.

### **Pandanus glauciphyllus** sp. nov.

Section Bryantia: heads solitary, ovate in outline, 4.5–5.5 cm. long, 3.5–4.5 cm. wide at base: drupes 200–300 in each head, unilocular, 1–1.2 cm. long, 6 mm. wide at the top, 4–6-sided, in dried material banded along the sides with yellow and orange, the exposed portions shining, the stigma slightly umbonate within a shallow depression.

A plant about 3 m. in height, the stem dark-gray, brown, or blackish, 25–40 cm. in diameter, with very short bracing roots, sometimes scarcely evident: leaves 0.4–1 m. long, with an extreme width of 2–2.6 cm., pale- or brownish-green above, glaucous beneath, midrib narrow, depressed above, somewhat prominent beneath, one vein on each side of the midrib conspicuous above, barely visible beneath, uniting with the midrib 1–2 cm. from the tip, the apical third of these two veins below their junction with the midrib antrorsely spinulose; midrib beneath antrorsely spinulose along apical 8–15 cm. and usually retrorsely spinulose for 1.5–6 cm. at base; leaf-margins spinulose throughout, antrorsely except sometimes near the base.

Type collected at Sax River, Province of Zamboanga, Mindanao, by R. S. Williams, *no. 2423*, in fruit, February 28, 1905.

This is closely allied to *P. polycephalus* Lam., and may be the species whose introduction into cultivation under that name is recorded by Nicholson * and by Warburg.†

## SANTALACEAE

THESIUM PSILOTOIDES Hance, Jour. Bot. 6 : 48. 1868

Originally described from China, but apparently well represented by *Williams 1310*, Baguio, Province of Benguet, northern Luzon; in flower, October 9, 1904. A genus not previously known in the Philippines.

## NYCTAGINACEAE

PISONIA LONGIROSTRIS Teijsm. & Binnend. Tijdschr. Nederl. Ind. 25 : 401. 1863

Collected on the island of Jolo, by R. S. Williams, *no. 3125*; in flower, July, 1905. Not previously reported from the Philippines.

## RANUNCULACEAE

### **Thalictrum philippinense** sp. nov.

Flowers probably perfect; certainly every young flower seen perfect, older ones on same or different plants lacking stamens and sepals: inflorescence a terminal 2–5-(usually 2- or 3-) flowered sessile cyme, simulating a panicle; pedicels slender, 1–5.5 cm. long; sepals 5, petaloid, 2.5–3.5 mm. long, 3-nerved, elliptic, cuneate at the base, obtuse at the apex, deciduous: stamens 25–35, early deciduous, 7.5 mm. long, the basal half of the filaments very slender, the upper half clavate, the anthers 0.5 mm. long, elliptic: maximum number of carpels seen 12, stipitate, at anthesis 5–6 mm. long, of which the stipe forms 2 mm. and the style 1 mm.: achenes including the stipe also 5–6 mm. long, 3-ribbed on each side, tipped by the persistent style.

A glabrous plant, 20 to 30 cm. high, with a rootstock only 3–5 mm. in length and somewhat tuberous roots: basal leaves on slender petioles 6–15 cm. long, 2–3-ternate, ultimate leaflets with petiolules 2.5–10 mm. long, the lateral leaflets 8–16 mm. long, orbicular-ovate in outline, rounded or truncate or subcordate at the base, 3-lobed, the lobes also usually notched, rounded or truncate or retuse at the apex, the terminal leaflets similar, slightly larger, upper leaves few, shorter-petioled, or the uppermost nearly sessile, similar to the basal but once or rarely twice ternate.

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* Ill. Dict. Gard. 3 : 18. 1878.

† Das Pflanzenreich $4^9$ : 69. 1900.

Type collected on steep shaded cliffs, near Baguio, Province of Benguet, northern Luzon, by R. S. Williams, *no. 1137*, in flower and fruit, June 22, 1904; also represented by *Williams 957*, from the same locality, in fruit, September 18, 1904.

## ANNONACEAE

### **Anaxagorea radiata** sp. nov.

Glabrous throughout: flowers single or less frequently in pairs, terminal upon leaf-bearing branchlets: carpels 12 to at least 20, radiately arranged, slightly scabrous, their stipes 1.5–2.2 cm. long, 1–1.5 mm. wide at the base, very gradually widening upwards, body of carpels 1.2–1.3 cm. long, 8–10 mm. wide, obliquely oval or almost spheric before dehiscence, longitudinally striate within except upon a thickened area near the apex; this area 6 mm. in diameter, somewhat irregular in outline, its outer edge or edges nearly parallel to the dorsal suture; carpels dehiscing along both sutures: seeds 2, collateral, 1.2–1.3 cm. long, 8 mm. wide, obovate, apiculate, flattened where pressed together, jet-black or amber-black, shining.

A shrub 2.5 m. high; bark of branchlets gray, roughened or striate: leaves petioled, elliptic to oblong, 9–16 cm. long, 4–7 cm. wide, acute or rounded at the base, obtuse or more often obtusely acuminate at the apex: the more conspicuous primary veins 6–8 on each side, with intervening ones often nearly as prominent, loosely arched-anastomosing and forming two submarginal veins.

Type collected by R. S. Williams, *no. 3108*, near the base of Mount Dajo, island of Jolo; in mature fruit, July 27, 1905.

Very similar in general appearance to *A. javanica* Blume, but easily distinguished by the terminal inflorescence and the more numerous carpels.

### **Cyathocalyx acuminatus** sp. nov.

Flowers fascicled on short lateral branches not opposed to leaves, usually 3–7 in each fascicle, borne on slender, straight pedicels 1.5–2 cm. long; pedicels and perianth ferruginous-tomentose: sepals 3, semicircular, 1.5–2 mm. long, 3 mm. wide at base: petals 6, yellowish-green, fragrant, valvate, in two rows, nearly equal in length, 2–2.2 cm. long, the basal 3 mm. of those of both rows closely arching over the stamens and carpels; apex of the hood white-tomentose within; hooded portion of outer petals about 5 mm. wide, upper portion of outer petals 2.5 mm. wide at the base, 3–3.5 mm. wide in the middle, tapering to an obtuse apex; inner petals subsimilar but narrower, the hood 3.5 mm. wide, base of upper portion 1.5 mm. wide, middle of upper portion 1.5–2 mm. wide: stamens about 40, 1–1.5 mm. long, the anther-cells concealed above by the connectives: carpels about 10, at anthesis 1 mm. long, yellowish-tomentose; mature carpels red, in all 1.5–2.5 cm. long, borne on stipes 4–7 mm. long, the body of the carpel 1–1.2 cm. wide; carpels with 1–3 transverse constrictions without, corresponding to as many divisions within, each 1-seeded; seeds therefore 2–4, obovate-orbicular in outline, 1 cm. long, 8 mm. wide, testa chestnut-brown, shining.

A small tree, about 7.5 m. high, and 7.5 cm. in diameter, with gray to blackish, striate bark, ferruginous-tomentose to glabrate: leaves borne on petioles 1–2 cm. long, chartaceous, elliptic or oblong, acute or somewhat rounded at the base, acuminate at the apex, in all 14–23 cm. long, 5–7.5 cm. wide, with pubescent petioles, midribs, and veins; primary veins usually 10 on each side of the midrib.

Type collected at Sax River, Province of Zamboanga, Mindanao, at an elevation of above 75 m., by R. S. Williams, *no. 2143*, in flower and fruit, February 8, 1905. Closely allied to *C. biovulatus* Boerl., from Borneo.

### **Mitrephora Merrillii** nom. nov.

*M. ferruginea* Merr. Bur. Govt. Lab. Publ. **17**: 16. 1904, in part. Not *M. ferruginea* Boerl.; Koord. Meded. 's Lands Plantentuin **19**: 335. 1898.

As already pointed out by Merrill this species was originally confused by him with the very similar *M. Lanotan* (Blanco) Merr., from which it is distinguishable by having leaves more numerously veined, elliptic or narrowly elliptic instead of linear-oblong, and densely ferruginous-pubescent carpels 3.5–4 cm. long.

All specimens seen of this species are from Lamao River and Mount Mariveles, Province of Bataan, Central Luzon: *Williams 111*; *Merrill 3728*; *Merrill, Decades Philipp. Forest Flora* (coll. *Borden*) *166*; *Elmer 6734, 7000*; *Forestry Bureau 61, 367, 513* (coll. *Barnes*), *2045* (coll. *Borden*), *2829* (coll. *Meyer*).

### **Mitrephora Williamsii** sp. nov.

Flowers fragrant, striped red and yellow, fascicled in condensed cymes, opposite the leaves, apparently unisexual, only male flowers seen: pedicels 5–8 mm. long, 2 mm. in diameter, covered with brownish tomentum, as are also the outer sides of the sepals and the outer row of petals: sepals 3, separated nearly to the base, broadly ovate, shortly and obtusely acuminate, 5–6 mm. long, 4 mm. wide at the base: petals of outer row 3, valvate in bud, similar in shape to the sepals but much larger, being 1.3–1.5 cm. long, 9–10 mm. wide at the base; inner petals 3, very dissimilar to the outer in shape, consisting of a claw 1 cm. long and 2 mm. wide, its width nearly constant throughout, bearing a rhomboid-orbicular hood 6–7 mm. long and 7.5 mm. wide, the inner surface of the hood ferruginous-tomentose and forming about 7 longitudinal folds: stamens numerous, 200–250, 0.8–1 mm. in length, the anther-cells covered at the apex by the connective.

A small tree 12 m. high, having a trunk 12.5 cm. in diameter: bark of ultimate branches dark-gray or black, longitudinally striate, the younger portions somewhat ferruginous-tomentose, becoming glabrate: leaves borne on stout petioles 12–18 mm. long, and 2.5–4 mm. thick, ovate, acute at the base, gradually narrowed above to an obtuse apex or barely acuminate, 20–32 cm. long, 7–11.5 cm. wide, the upper surface somewhat olive-green, glabrous, shining, the under surface brownish-green, slightly ferruginous-pubescent on the midrib and primary veins; midrib and primary veins immersed above, conspicuous beneath, primary veins 20–25 on each side of midrib.

Type collected at Sax River, Province of Zamboanga, Mindanao, by R. S. Williams, *no. 2188*, in flower, March 3, 1905.

### **Polyalthia clusiflora** (Merr.)

*Unona clusiflora* Merr. Bur. Govt. Lab. Publ. **35**: 13. 1905.

Examination of several collections of this species showing that the carpels each contain a single ovule, attached at the very base of the carpel, it is necessary to transfer it to the section *Monoon* of *Polyalthia*.

Widely distributed in the Philippines, being known from Luzon, Leyte, and Mindanao.

### **Uvaria rubra** sp. nov.

Flowers hermaphrodite, solitary on leaf-bearing branches, but not opposed by leaves: pedicels and calyx ferruginous-tomentose;

torus globose in fruit, flattened on top in flower; calyx in bud separated into lobes only at the tip, ultimately 2- or 3-lobed, semiorbicular, lobes about 2.5 cm. long and 3 cm. wide across middle, shortly and obtusely acuminate: petals dark-red, 6, in two rows, subequal, imbricate in bud, coriaceous, narrowly to broadly elliptic, 3.5–4.4 cm. long, 1.7–2.4 cm. wide, attached by 5–6 cm. of their bases, rounded at the apex: stamens 200–250, 7 mm. long, 1 mm. wide, the anther-cells covered at the tip by the connectives: carpels about 100, when nearing maturity about 4 cm. long and 8 mm. in diameter, nearly cylindric, apiculate, ferruginous-tomentose, rarely (and then only slightly) constricted, their walls granular; ovules few (12).

A low bush or sometimes climbing over trees, its stems 1.5–2 cm. in diameter, with light- to dark-gray bark, scaly becoming striate; ferruginous-tomentose on the younger parts, becoming glabrous: leaves 15–32 cm. long, 5–12.5 cm. wide, borne on petioles 3–8 mm. long, elliptic-obovate, rounded or acute or sharply acuminate at the apex, cordate at the base, bluish-green above, paler and reddish-veined beneath, glabrous except on the midrib and primary veins of the upper surface; primary veins on each side of the midrib 15–20.

Type collected at Santa Cruz, Province of Davao, Mindanao, by R. S. Williams, *no. 3042*, in flower, June 29, 1905: also represented by *Williams 3027* from the same locality, in fruit, July 11, 1905.

Very similar in its vegetative aspect to *U. scandens*, but at once distinguishable by the entirely different inflorescence and the larger flowers.

### **Uvaria scandens** sp. nov.

Flowers hermaphrodite, borne in short cymes or rarely singly, upon short, fascicled, warty, suberose branches from leafless portions of the stem, the inflorescence throughout ferruginous-tomentose: pedicels at anthesis 8–10 mm. long, bracteoles orbicular-ovate, somewhat clasping: torus depressed-hemispheric; calyx undivided in bud except at the extreme apex, gradually splitting, at first leaving only a triangular or semilunar opening, until at anthesis the 3 or rarely 4 lobes are separated to within 2.5 mm. of the base; calyx-lobes suborbicular, broadest a little below the middle, 8–10 mm. long, 9–10 mm. wide: petals imbricate in bud, subequal, broadly oval or ovate, all ultimately spreading, 13–15 mm. long, 10–11 mm. wide: stamens about 500 in number, 1.7–1.8 mm. long, the anther cells covered at the apex by the connective:

carpels 50 or more, stellate-tomentose, at anthesis about 3 mm. long, enlarging later, each containing 8–10 ovules: fruit not seen.

Climbing and twining over trees, its stems 5–6 cm. in diameter, wood yellowish, bark of older portions light- to dark-gray, somewhat furrowed, bark of younger branches yellowish-gray, scaly, elongating into furrows, younger portions ferruginous-tomentose, becoming glabrous: leaves borne on petioles 3–7 mm. long, elliptic to obovate, subcordate to acute at the base, somewhat abruptly contracted at the apex into an acumen 1.5–2 cm. long in mature leaves, 15–25 cm. long, 7.5–9.5 cm. wide, bluish-green above, paler beneath, glabrous above except upon the somewhat immersed ferruginous-pubescent midrib and primary veins, minutely tomentose beneath; primary veins 12–15 on each side of the midrib, oblique, arching near the margin, secondary veins anastomosing, somewhat conspicuous.

Type collected at Santa Cruz, Province of Davao, Mindanao, by R. S. Williams, *no. 2764*, with flowers in all stages, May 5, 1905.

## SABIACEAE

### **Sabia philippinensis** sp. nov.

Flowers green, small, in terminal or subterminal compound cymes: pedicels slender, 2–4 mm. long, calyx about 1.2 mm. long, united for about three-fourths of its length, its lobes 5, ovate, obtuse: petals white, 5, opposite the calyx-lobes, and exceeding them in length: stamens 5, opposite the petals and calyx-lobes, about 1 mm. long, comparatively thick: ovary 1, exserted: fruit baccate, 1.5 cm. long and nearly 1 cm. in diameter, tipped by the persistent stigma, 2-celled.

A glabrous woody vine, with stems over 6 m. long and 1–1.5 cm. in diameter, climbing over trees: the older parts of the stem with light-gray bark, young shoots zigzag with striate yellowish-green bark: petioles 6–10 mm. long, slender, grooved on the upper surface; leaves alternate, entire, or somewhat wavy on the margins, olivaceous on the upper surface, green beneath, lanceolate or oblong-lanceolate, acute at the base, acute or acuminate and usually mucronate at the apex, primary veins on each side of the midrib about 12, arched-anastomosing, secondary and tertiary venation also conspicuous especially beneath, one or two submarginal veins present.

Type collected near Baguio, Province of Benguet, northern Luzon, by R. S. Williams, *no. 1445*, with young flowers and fruit, November 8, 1904.

This genus has not hitherto been reported from the Philippines. This species is closely allied to *S. Swinhoei* Hemsley, from Formosa, but seems to be distinguished by constantly narrower and much more attenuate leaves. The flowers described above were hardly sufficiently mature.

## ELAEOCARPACEAE

### **Elaeocarpus venosus** sp. nov.

Flowers racemed in the axils of the upper leaves; racemes 8–12 cm. long, the rachises 2–2.5 mm. in diameter, angled, together with the peduncles ferruginous-silky-tomentose; flowers usually 6–12 on a raceme, pedicels spreading or more often decurrent, 1.6–1.8 mm. in diameter, at anthesis 8–10 mm. long, each subtended by an ovate to obovate bract 8–12 mm. long and 7–8 mm. wide; flower-buds ovate; calyx-lobes 5, lanceolate, when mature 12–12.5 mm. long, separated for about four-fifths of their length, coriaceous, subacute at the apex, densely ferruginous-tomentose without, within less markedly pubescent but conspicuously 3-nerved: petals 5, obovate, truncate at base, fimbriate to a depth of 1–4.5 mm. at the rounded or truncate apex, 1–1.4 cm. long, 2.5–3 mm. wide at the base, 6–7 mm. wide at the apex, densely silky-tomentose: stamens about 60, linear, very minutely antrorsely barbed, 5–6 mm. long, the filaments 1–1.5 mm. long, the anther-tips free, acute, sometimes recurving: ovary sessile, densely golden-brown, silky-tomentose, globose, 3.5–4 mm. in diameter, 3-celled with 6–8 ovules in each cell: fruit blue, drupaceous, glabrous, oval, 2.3–2.7 cm. long, 2.1–2.2 cm. in diameter; stone 2.1–2.4 cm. long, 1.6–1.7 cm. in diameter, villose and variously channeled without, 3-celled, each cell with one seed.

A tree 9 m. high and 15 cm. in diameter: bark dark- or brownish-gray, furrowed, marked by the scars of fallen leaves, nearly glabrous: leaves stiff, coriaceous, alternate, borne on petioles 7.5–12 mm. long and 2.5–3 mm. wide, elliptic-obovate, entire, the margins revolute, acute or somewhat rounded and more or less decurrent at the base, truncate or rounded or rarely shortly and obtusely acuminate at the apex, glabrous and shining above, when young tomentose beneath, becoming glabrous; veins reddish on the upper surface, yellowish or whitish beneath, midrib raised above both surfaces except the tip of the upper, primary veins immersed in the upper surface but projecting from the under, these and the secondary and tertiary veins very conspicuous beneath; primary veins 10–12 on each side of the midrib.

Type collected on Mount Santo Tomas (Tonglon), province of Benguet, northern Luzon, by R. S. Williams, *no. 2002*, in flower and fruit, November 29, 1904. A species closely allied to *E. tuberculatus* Roxb., but distinguished by its 3-celled ovary, differently veined leaves, and otherwise.

## THYMELAEACEAE

### **Daphne luzonica** sp. nov.

Flowers pale-yellow, solitary or few, terminal, borne on peduncles 2–3 mm. long, trumpet-shaped, 13–14 mm. long, the receptacle and calyx two-thirds and one-third respectively of this length: sepals 4, lanceolate, obtuse at the apex, ciliate especially at the apex: petals none: stamens 8, in two rows: anthers subsessile, linear-oblong, 1.5–2 mm. long, dehiscing longitudinally: ovary superior, without special "receptacle-figuration" at the base, at anthesis 3.5 mm. long, 1.5 mm. wide, 1-celled, 1-ovuled; stigma sessile, 2-lobed: fruit unknown.

A slender bush, 1.5 m. high, with brownish, striate bark, or darker on the youngest shoots: glabrous except at the ends of the branchlets: leaves on petioles 2–4 mm. long, alternate or crowded at the ends of the branches and then nearly opposite, coriaceous, brownish above, at least on dried specimens, pale beneath, elliptic, cuneate at the base, retuse at the apex, 6.5–8.5 cm. long, 1.6–2.1 cm. wide, entire, primary veins on either side 6–8, irregularly anastomosing.

Type collected near the summit of Mount Santo Tomas (Tonglon), Province of Benguet, northern Luzon, by R. S. Williams, *no. 1535*, in flower, November 29, 1904.

This species is very closely allied to *Henry 11,321*, from Mengtse, Yunnan, China, as yet unnamed. The genus is not hitherto recorded from the Philippines.

## MELASTOMATACEAE

### **Sarcopyramis delicata** sp. nov.

Flowers solitary, terminal, borne on peduncles 3–5 mm. long, surrounded by and at anthesis overtopping a whorl of bracts usually similar to the leaves but smaller: calyx-tube triangular-hemispheric, about 5 mm. long, its margin at first gradually but finally abruptly contracted into 4 lanceolate lobes 1.5 mm. long, and each bearing 2 or 3 whitish hairs also 1.5 mm. long: petals 4, 11–14 mm. long, pink-lilac, oblong or obovate, shallowly 3-lobed at the apex, acuminate, apiculate: stamens 8, alike, about 2.5–3 mm. long, the filaments somewhat dilated towards the base, anthers 0.6–0.7 mm. long, elliptic-obovate, obcordate, downward prolongation of the connective very short: style 4 mm. long: fruit unknown.

A slender herb, simple or sparingly branched, erect or somewhat prostrate, 6–15 cm. high; stem winged above, angled below: leaves membranaceous, opposite, ovate, obtuse and mucronate at the apex, acute to rounded at the base, variable in length, attaining 3 cm. inclusive of the slender 4–5 mm. long petioles, 3-nerved, dentate-ciliate on the margins, and with one or rarely two rows on each side of the midrib of whitish hairs exceeding 1 mm. in length and about 2 mm. apart.

Type collected by R. S. Williams, *no. 1276*, on Mount Santo Tomas, Province of Benguet, northern Luzon, in flower, July 1, 1904; also at the same locality, *no. 1350*, October 12, 1904; also represented by *Elmer 8806*, Baguio, Province of Benguet. Mr. Merrill has already reported it from Mount Halcon, Mindoro, and has further supplied me with the following additional data regarding its occurrence in northern Luzon: *4809 Merrill*, Pauai, 30 miles north of Baguio, Province of Benguet, mossy forest at 6800 ft.; *4608*, *4491 Merrill*, Mount Data, Province of Lepanto, on earth, prostrate logs and mossy tree-trunks, in mossy forests at 7000 ft.

## CLETHRACEAE

### **Clethra Williamsii** sp. nov.

Inflorescence a terminal panicle, composed of 7–12 racemes, 15–20 cm. in length, all its branches, the bracts, pedicels, and calyx densely covered with gray tomentum interspersed with very frequent, rust-colored, stellate hairs 1 mm. or less in length, the latter scantily developed on the pedicels, but dense on at least the margins of the calyx-lobes: pedicels about 3.5 mm. long, slender, broadest at the base, tapering to the apex, ascending or spreading, bracts linear, 4 mm. long, not early deciduous: calyx about 3 mm. long, its lobes 2 mm. long, ovate, obtuse at the apex: corolla-lobes broadly oval to suborbicular, 3–4 mm. long, 2.5 mm. wide, broadest at the middle; stamens nearly equaling the corolla, the anthers diverging above: ovary also tomentose; style becoming exserted, expanded at the slightly three-lobed stigma.

A tree, about 9 m. high and 12.5 cm. in diameter; bark of upper branches ashen; ultimate branches angled, rusty-tomentose: leaves alternate, or at the extremities of the branches verticillate, the petioles 1–1.7 cm. long, tomentose; young leaves elliptic, mature ones bluish-green above, dull-green beneath, 10–13 cm. long, 3.75–4.75 cm. wide, broadest a little above the middle, slightly inequilateral, elliptic to elliptic-obovate, cuneate at the base, acute at the apex, sharply but somewhat coarsely serrate except at the base, serrations callous at the tips, midrib and veins on upper surface canaliculate, tomentose, on lower surface very prominent, appressed-tomentose, reticulations also prominent.

Type collected on Mount Apo, Mindanao, at an elevation of 2,100 m., by R. S. Williams, *no. 2596*, in flower, March 31, 1905. Native (Bogobo) name: Cal yar pe.

In order to meet the requirements of the Vienna Rules, Latin diagnoses are appended of the species believed to be described herein for the first time.

*Pandanus glauciphyllus:* capitulis solitariis, ovatis; drupis permultis, unilocularibus, nitidis; foliis metralibus, subtus glaucis.

*Thalictrum philippinense:* floribus hermaphroditis, cymis paucifloris, sepalis petaloideis, ellipticis, carpellis stipitatis.

*Anaxagorea radiata:* floribus solitariis vel rarius geminis, terminalibus; carpellis plerisque, radiantibus, stipitatis, seminibus duobus, collateralibus.

*Cyathocalyx acuminatus:* floribus in ramis brevibus non foliis oppositis fasciculatis; petalis infra arcuatis, staminibus brevibus, antheris connectivo subditis; carpellis maturis rubris, stipitatis, 2–4-locularibus.

*Mitrephora Williamsii:* floribus in cymis foliis oppositis fasciculatis, masculinis tantum visis; petalis valvatis, exterioribus sepalis similibus, interioribus dissimilibus; staminibus numerosis.

*Uvaria rubra:* floribus solitariis, hermaphroditis, petalis similibus, imbricatis, ellipticis, rubris; staminibus carpellisque multis, his cylindraceis, apiculatis.

*Uvaria scandens:* floribus hermaphroditis, cymosis vel rarius solitariis; petalis imbricatis, similibus; staminibus numerosis; carpellis plerisque.

*Sabia philippinensis:* floribus parvis, cymosis, terminalibus vel subterminalibus: calycis segmentis, petalis, staminibusque oppositis; bacca biloculari.

*Elaeocarpus venosus:* floribus racemosis; petalis obovatis, fimbriatis; ovario globoso, triloculari; fructu drupaceo.

*Daphne luzonica:* floribus solitariis vel saltem paucis, terminalibus; sepalis lanceolatis; petalis nullis; ovario uniloculari, uniovulato.

*Sarcopyramis delicata:* floribus solitariis, terminalibus; petalis oblongis vel obovatis; staminibus similibus, connectivo brevissime prolongato.

*Clethra Williamsii:* floribus terminalibus, paniculatis; calycis segmentis ovatis, obtusis, corollae segmentis ovalibus vel suborbicularibus; foliis ellipticis vel ellipticis-obovatis, serratis.

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# STUDIES IN THE NORTH AMERICAN CONVOLVULACEAE—IV. THE GENUS EXOGONIUM

By HOMER DOLIVER HOUSE

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# Studies in the North American Convolvulaceae — IV. The genus Exogonium

Homer Doliver House

(with plates 1 and 2)

The genus *Exogonium* is based upon *Ipomoea bracteata* Cav., a Mexican species, and with several other West Indian species forms one of the natural groups of species usually referred to *Ipomoea.* The group is recognized as a genus by Peter and by Hallier, and as a section of *Ipomoea* by Grisebach and by Meissner. *Ipomoea Purga*, which has sometimes been referred to *Exogonium*, appears to be more closely related to a group in *Ipomoea*, of which not all the members possess the salverform corolla and exserted stamens of *I. Purga*, and should more properly be retained in *Ipomoea.* Until very recently the genus was regarded as almost wholly confined to the West Indies. Recent collections in southern Mexico have shown that four species occur in Mexico, one of them apparently identical with *E. argentifolium*, of the West Indies.

### EXOGONIUM Choisy, Mém. Soc. Phys. Genèv. 6: 443. 1833. — In DC. Prodr. 9: 346. 1845

Perennial, trailing or twining vines, usually with woody stems. Leaf-blades entire or lobed. Flowers several on axillary peduncles or solitary; bracts large and colored, sometimes inconspicuous or absent. Sepals membranaceous or subherbaceous, equal or unequal, never awned. Corolla scarlet or white; the tube often slender and constricted at the throat or expanding above in a salverform or funnelform limb. Stamens and style exserted or protruding, rarely included. Ovary 2-celled, 4-ovuled. Capsules ovoid, thick-walled, apiculate. Seeds with a long coma of hairs on the dorsal angles, rarely pubescent or glabrous. Stigmas capitately 2-lobed.

Type species: *Ipomoea bracteata* Cav.

The species, about 20 in number, are all confined to North America.

**Key to the species**

- A. Inflorescence with conspicuous bracts.
  - Bracts ovate-elliptical to linear-lanceolate.
    - Inflorescence long-peduncled.
      - Bracts 2–3 cm. long.
        - Bracts elliptical-obovate, obtuse; sepals obtuse. 1. *E. racemosum.*
        - Bracts linear-lanceolate; sepals acuminate. 2. *E. Wrightii.*
      - Bracts 1 cm. long, green or tinged with red, subherbaceous. 3. *E. Rudophii.*
    - Inflorescence sessile or nearly so; bracts linear-lanceolate; foliage velvety-pubescent. 4. *E. velutifolium.*
  - Bracts reniform-ovate, acute, red; inflorescence spicate. 5. *E. bracteatum.*
- B. Inflorescence without conspicuous bracts.
  - Leaf-blades silvery-canescent beneath.
    - Leaf-blades cordate or subcordate at base.
      - Corolla 5 cm. long; leaf-blades silvery beneath, often 3-lobed at the base. 6. *E. jalapoides.*
      - Corolla 3 cm. long or less; leaf-blades sericeous beneath, not lobed. 7. *E. fuchsioides.*
    - Leaf-blades not cordate; corolla about 3 cm. long.
      - Corolla glabrous. Cuban. 8. *E. argentifolium.*
      - Corolla pubescent. Mexican. 9. *E. Conzattii.*
  - Leaf-blades neither silvery nor sericeous beneath.
    - Corolla salverform, scarlet; leaf-blades entire, lobed or 3–5 parted. 10. *E. microdactylum.*
    - Corolla-limb not salverform.
      - Leaf-blades entire or repand.
        - Corolla-limb deeply 5-parted, the lobes lanceolate, acute.
          - Corolla golden-yellow. Mexican. 11. *E. luteum.*
          - Corolla scarlet. West Indian. 12. *E. repandum.*
        - Corolla with 5 short, triangular, scarcely spreading, acute lobes. 13. *E. filiforme.*
      - Leaf-blades lobed or 3–9-divided.
        - Stems creeping; blades very small.
          - Corolla scarlet, constricted above. 14. *E. arenarium.*
          - Corolla white, funnelform above. 15. *E. Eggersii.*
        - Stems twining or trailing.
          - Corolla white; leaf-blades sinuately lobed. 16. *E. cubense.*
          - Corolla scarlet; blades divided.
            - Sepals equal; leaf-segments obtuse.
              - Leaf-segments linear; corolla scarlet. 17. *E. eriospermum.*
              - Leaf-segments obovate; corolla greenish; stems minutely pilose. 18. *E. viridiflorum.*
            - Sepals unequal.
              - Leaf-segments oblong-lanceolate, acuminate. 19. *E. leuconeurum.*
              - Leaf-segments narrowly lanceolate, obtuse; corolla-tube slightly inflated. 20. *E. pedatum.*

1. EXOGONIUM RACEMOSUM (Poir.) Choisy, Conv. Rar. 128. 1837. — In DC. Prodr. 9: 346. 1845

*Ipomoea racemosa* Poir. in Lam. Encyc. Suppl. 4: 633. 1816.
*Convolvulus racemosus* Spreng. Syst. **1**: 600. 1825.
*Convolvulus altissimus* Spreng. *l. c.* 613.
*Ipomoea altissima* Bert.; G. Don, Gen. Syst. 4: 273. 1838.

A stout, woody, perennial, branching vine, several m. long, finely pubescent: leaf-blades oblong-ovate, deeply cordate, obtuse, 3–6 cm. long; petioles 1–3 cm. long: peduncles racemosely 2–10-flowered, 6–10 cm. long, each calyx closely subtended by 2–3 elliptical-oblong, obtuse, rose-colored bracts: sepals membranaceous, similar to the bracts: corolla lavender, about 4.5 cm. long, the cylindrical tube slightly constricted above. (PLATE 1, FIGURE *c*.)

TYPE LOCALITY: St. Domingo.

DISTRIBUTION: St. Domingo and Hayti. Reported from Cuba.

SPECIMENS EXAMINED: Hayti, La Brande to Mt. Balance, *Nash & Taylor 1696*, 1905.

### 2. **Exogonium Wrightii** sp. nov.

*Ipomoea racemosa* Griseb. Cat. Pl. Cub. 205. 1866. Not *I. racemosa* Poir. 1816.

A stout, woody, perennial, twining vine: stems appressed-pubescent above: leaf-blades ovate, obtuse, deeply cordate, 5–8 cm. long, glabrate above, densely appressed-pubescent beneath, strongly reticulate-veined: peduncles elongated, often terminating branches and leafy, 10–20 cm. long, several-flowered; pedicels filiform, 2–4 cm. long; bracts linear-lanceolate, 1.5–2 cm. long, pubescent: sepals lanceolate, acuminate, appressed-pubescent below, 18–22 mm. long: corolla reddish-purple, salverform, 4 cm. long, the limb as broad: stamens and style exserted 6–10 mm. (PLATE 1, FIGURE *d*.)

CUBA: "N. Sophie [Isle of Pines], climbing to tops of tall trees," *C. Wright 1650*, 1859–1860. (Type in the Gray Herbarium.)

### 3. **Exogonium Rudolphii** (Roem. & Schult.)

*Ipomoea bracteata* Rudol.; Ledeb. in Schrad. Neues Jour. Bot. **2**: 292. 1807. Not *I. bracteata* Cav. 1799.
*Ipomoea Rudolphii* Roem. & Schult. Syst. 4: 222. 1819.
*Pharbitis bracteata* Choisy in DC. Prodr. 9: 344. 1845.
*Rivea bracteata* Hallier f. Bot. Jahrb. **18**: 158. 1894.

Resembling the preceding: stems retrorsely strigose-pubescent: leaf-blades deltoid-ovate, cordate, entire or somewhat 3-lobed, glabrous above, pubescent beneath: peduncles 1- or loosely few-flowered; bracts ovate, obtuse: sepals herbaceous, similar to the bracts but smaller, sometimes acute, 1 cm. long or less: corolla subsalverform, scarlet, 3–4 cm. long; limb 2.5–3 cm. broad: stamens and style exserted. (Plate 1, figure *a*.)

Type locality: St. Domingo.

Distribution: St. Domingo and Cuba.

Specimens examined: Cuba, *C. Wright 3096* (in herb. Gray).

### 4. **Exogonium velutifolium** sp. nov.

A slender, woody, high-climbing, irregular vine: stems velvety-pubescent above: leaf-blades oblong-ovate, obtuse, rounded at the base, entire or irregularly crenate-lobed toward the base, 6–30 mm. long, velvety-pubescent; petioles 2–5 mm. long: flowers 2 or 3 together, sessile or nearly so near the ends of the branches; bracts and sepals linear-lanceolate: sepals subequal, acuminate, 7–8 mm. long, tomentose: corolla crimson, glabrous, 3 cm. long or less, slightly constricted at the throat, the slightly spreading limb with 5 rounded lobes, 5–6 mm. long and as broad: stamens and style protruding. (Plate 1, figure *b*.)

Mexico: Oaxaca, west side of the valley of Cuicatlan, 2000–4000 ft. alt., *E. W. Nelson 1887*, Nov. 9, 1894 (type in herb. Gray; dupl. in Nat. Herb.).

### 5. Exogonium bracteatum (Cav.) Choisy; G. Don, Gen. Syst. **4**: 264. 1838

*Ipomoea bracteata* Cav. Ic. **5**: 51. *pl. 447*. 1799.

*Ipomoea spicata* H. B. K. Nov. Gen. et Sp. **3**: 112. 1819.

*Ipomoea cincta* Roem. & Schult. Syst. **4**: 254. 1819.

*Convolvulus obvallatus* Spreng. Syst. **1**: 595. 1825.

*Exogonium spicatum* Choisy, Conv. Rar. 128. 1837.—In DC. Prodr. **9**: 347. 1854.

*Exogonium Olivae* Bárcena, Viaje Cav. Cacahuam. 29. 1874.

*Convolvulus bractiflorus* Sessé & Moc. Pl. Nov. Hisp. 23. 1887.

Type locality: Near Mazatlan, Mexico.

Distribution: Lower California and western Mexico to Central America.

Specimens examined: Sonora, *Palmer 313*, 1890, *10*, 1890; Sinaloa, *W. G. Wright 1258*, 1899, *Palmer 1787*, 1891, *Lamb 450*, 1895; Morelos, *Bilimek 99*, 1866, *Pringle 8012*, 1899; Chihuahua, *Palmer 294, 296*, 1885.

### **Exogonium bracteatum pubescens** (Rob. & Greenm.)

*Ipomoea bracteata* var. *pubescens* Rob. & Greenm. Am. Jour. Sci. 50: 160. 1895.

MEXICO: Jalisco, Barranca near Guadalajara, *Pringle 4734*, 1894.

### 6. **Exogonium jalapoides** (Griseb.)

*Ipomoea jalapoides* Griseb. Cat. Pl. Cub. 202. 1866.

Stems woody below, densely pubescent: leaf-blades oblong-lanceolate, entire, 3–5 cm. long, or 3-lobed at the base, the middle lobe lanceolate, 4–5 cm. long, lateral lobes oblique, 2 cm. long or less, densely appressed-pubescent above: peduncles 1–3 flowered: sepals oblong, obtuse, 7–9 mm. long, densely tomentose without: corolla scarlet, the limb fully 4 cm. broad.

TYPE LOCALITY: Cuba.

DISTRIBUTION: Cuba.

SPECIMENS EXAMINED: *C. Wright 3097* (co-type in herb. Columbia Univ.).

### 7. **Exogonium fuchsioides** (Griseb.)

*Ipomoea fuchsioides* Griseb. Cat. Pl. Cub. 205. 1866.

Stems finely appressed-pubescent: leaf-blades narrowly ovate-lanceolate, acuminate, rounded or subcordate at the base, green and appressed-pubescent above, pale and sericeous-pubescent beneath, 2–4 cm. long, sometimes 5–7 cm. long, obtuse, 3–4 cm. wide and obtusely auricled at the base: pedicels and calyx glabrous: sepals unequal, 5–6 mm. long, obtuse, tinged with red: corolla-tube 3 cm. long, 4–5 mm. in diameter; limb crimson, 1.5–2 cm. broad with 5 rounded lobes.

TYPE LOCALITY: Cuba, "Bahia Honda."

DISTRIBUTION: Cuba.

SPECIMENS EXAMINED: *C. Wright 3095* (in herb. Gray). The co-type in the Gray Herbarium is mixed with the entire-leaved form of *E. microdactylum*, which perhaps accounts for the mistaken identification of the latter in most herbaria as "*Ipomoea fuchsioides*." The variety *parvifolia* Griseb. *l. c.* appears to be but a small leaf-form, while the variety *glabra* belongs to the entire-leafed variety of *E. microdactylum*.

### 8. **Exogonium argentifolium** (A. Rich.)

*Ipomoea? argentifolia* A. Rich. in Sagra, Hist. Fis. Cuba **11**: 131. 1850.

*Ipomoea praecox* Wright [in Sauv. Fl. Cub. 107] Anal. Acad. Habana **7**: 46. 1870.

A stout twining vine: stems tomentose above: leaf-blades oblong-lanceolate to elliptical-oblong, acute or rounded at the base, the apex acute or obtuse, 2–10 cm. long, woolly above, becoming glabrate: sepals suborbicular, obtuse, 5–6 mm. long, woolly or tomentose without, equal: corolla salverform, the tube 6–7 mm. in diameter; the limb 3 cm. broad.

TYPE LOCALITY: "Prope Nouvelle Sophie," Isle of Pines.

DISTRIBUTION: Cuba, Isle of Pines, and southern Mexico.

SPECIMENS EXAMINED: Cuba, *C. Wright 449, 3646; Cook* 1905. Isle of Pines, *Curtiss 489*, 1904, *Rowlee 182*, 1901. Mexico: Oaxaca, *Conzatti & Gonzalez 332*, 1894, *Pringle 5636*, 1894; Puebla, *E. W. Nelson 2009*, 1895, *Pringle 7016*, 1895.

### 9. **Exogonium Conzattii** (Greenm.)

*Ipomoea Conzattii* Greenm. Field. Col. Mus. Publ. Bot. **2**: 258. 1907.

Resembling the preceding: leaf-blades not seen: flowers in dense, many-flowered, subsessile clusters; pedicels and peduncles tomentose: sepals slightly unequal, broadly ovate, obtuse, tinged with red: corolla-tube 3 cm. long, the scarlet limb 2 cm. broad, pubescent without: capsules 10–12 mm. in diameter, 2-celled; coma of hairs on the seeds white.

TYPE LOCALITY: Almoloyas, Guerrero, Mexico.

DISTRIBUTION: Southern Mexico.

SPECIMENS EXAMINED: Guerrero, *E. W. Nelson 2095*, 1894 (in herb. Gray and Nat. Herb.). (The type, *Conzatti 1666*, 1906, in herb. Field Mus., not seen.)

### 10. **Exogonium microdactylum** (Griseb.)

*Ipomoea microdactyla* Griseb. Cat. Pl. Cub. 204. 1866.

A glabrous twining vine: stems woody below, striated or muricate: leaf-blades 3–5-lobed or subentire, 3–6 cm. long, thick-textured, lobes usually oblanceolate, obtuse, reticulate-veined: peduncles 1–3-flowered: sepals unequal, orbicular-ovate, obtuse, 5–7 mm. long: corolla scarlet, subsalverform, 3–4 cm. long, the limb 3–5 cm. broad and slightly 5-lobed: capsules 10 mm. in diameter, ovoid, apiculate.

TYPE LOCALITY: Cuba.

DISTRIBUTION: Cuba and the Bahamas.

SPECIMENS EXAMINED: Cuba, *C. Wright 3094* (co-type in herb. Columbia Univ.), *Britton, Britton, & Shafer 735*, 1903; Bahamas, Andros, *Northrop 394*, 1890, *Brace 6756*, 1907; Great Exuma, *Britton & Millspaugh 2923*, 1905; Eleuthera, *Britton & Millspaugh 5594*, 1905; Conception Island, *Britton & Millspaugh 6029*, 1907; Long Cay, *Brace 4010, 4173*, 1905; Acklin's Island, *Brace 4280*, 1906; New Providence, *Curtiss 211*, 1903.

### **Exogonium microdactylum integrifolium** var. nov.

*Ipomoea repandi* Griseb. *l. c.* 204. Not *I. repanda* Jacq. 1760.

Leaf-blades nearly or quite entire, oblong-ovate, subcordate, truncate or sometimes obtuse at the base.

CUBA: *C. Wright 3102* (co-type in herb. Columbia Univ.), *Cook 46*, 1906, *Combs 607*, 1895, *Baker 2171*, 1904. BAHAMAS: New Providence, *Britton & Millspaugh 2105*, 1905, *Britton & Brace 800*, 1904; Crooked Island, *Brace 4627, 4739*, 1906; Rum Cay, *Brace 3982*, 1905; Berry Islands, *Britton & Millspaugh 2336*, 1905; Inagua, *Nash & Taylor 1258, 1310*, 1904; Andros, *Brace 6988*, 1907; Great Bahama, *Brace 3569, 3701*, 1905; Abaco, *Brace 1593*, 1904. Watling's Island, *Wilson 7212*, 1907; North Caicos, *Wilson 7716*, 1907; Mariguana, *Wilson 7521*, 1907. FLORIDA: Pinelands near Cutler, *Small & Carter 788, 816*, 1903. Long Key, *Small & Wilson 1971*, 1903.

### 11. **Exogonium luteum** sp. nov.

A stout, woody, twining vine, minutely pubescent: leaf-blades triangular-ovate, acuminate, 5–8 cm. long, minutely but densely pubescent above, velvety-pubescent beneath; petioles short: peduncles 5–10 cm. long, tomentose, cymosely many-flowered; pedicels 1.5–3 cm. long: sepals slightly unequal, ovate, obtuse, glabrous or the outer tomentose, 4–6 mm. long: corolla 3–5 cm. long, golden yellow, the straight tube 5 mm. in diameter, the spreading limb divided to the top of the tube into 5 lanceolate, acute lobes about 15 mm. long, each with a small tuft of white hairs at the tip: stamens and style long-exserted; the sagittate anthers 3.5 mm. long. (PLATE 2, FIGURE *c*.)

MEXICO: Oaxaca, Cuesta de Chiquihuetlan, 3300 ft. alt., *Conzatti & Gonzales 668*, Sept. 2, 1895 (type in herb. Gray).

12. EXOGONIUM REPANDUM (Jacq.) Choisy, Conv. Rar. 128. 1837. — In DC. Prodr. **9**: 347. 1845

*Ipomoea repanda* Jacq. Pl. Carib. 13. 1760. — Select. Stirp. Amer. 28. *pl. 20.* 1763. — L. Sp. Pl. ed. 2, 1668. 1763.

*Convolvulus repandus* Desr. in Lam. Encyc. **3**: 555. 1789.

TYPE LOCALITY: St. Francis, Martinique.

DISTRIBUTION: In thickets, Porto Rico and the Lesser Antilles.

SPECIMENS EXAMINED: Porto Rico, *Sintenis 5330,* 1886; Martinique, *Duss 1890,* 1880; Guadeloupe, *Duss 2478,* 1892; Grenada, *Broadway,* 1905; Montserrat, *Shafer 401,* 1907.

13. EXOGONIUM FILIFORME (Jacq.) Choisy, Conv. Rar. 127. 1837. — In DC. Prodr. **9**: 347. 1845

*Ipomoea filiformis* Jacq. Pl. Carib. 13. 1760. — Select. Stirp. Amer. 27. *pl. 19.* 1763.

*Convolvulus filiformis* Desr. in Lam. Encyc. **3**: 555. 1789.

TYPE LOCALITY: Martinique.

DISTRIBUTION: In thickets, Porto Rico and the Lesser Antilles.

SPECIMENS EXAMINED: Porto Rico, *Heller,* 1902; Martinique, *Duss 425,* 1879; Guadeloupe, *Madiana 23,* 1872, *Duss 3085,* 1893; St. Thomas, *Eggers 48,* 1887; St. Croix, *Ricksecker 39,* 1895.

14. EXOGONIUM ARENARIUM Choisy, Conv. Rar. 129. *pl. 1.* 1837. — In DC. Prodr. **9**: 347. 1845

*Ipomoea arenaria* Steud. Nom. ed. 2. 815. 1841. Not *I. arenaria* Roem. & Schult. 1819.

*Ipomoea Steudeli* Millsp. Field. Col. Mus. Publ. Bot. **2**: 86. 1901.

TYPE LOCALITY: Caribbean Islands.

DISTRIBUTION: Littoral, Porto Rico and the Lesser Antilles.

SPECIMENS EXAMINED: Porto Rico, *Underwood & Griggs 544, 547,* 1901, *Sintenis 3457,* 1888, *Heller 6170,* 1902; Culebra, *Britton & Wheeler 30,* 1906. (PLATE 2, FIGURE *d.*)

15. **Exogonium Eggersii** sp. nov.

A perennial, slender, trailing vine, exactly simulating the preceding: leaf-blades 3–12 mm. long, nearly as broad, obcordate or notched at the apex, the base truncate or hastately lobed: peduncles 6–8 mm. long, 1-flowered: sepals equal, orbicular-ovate, glabrous, 5–6 mm. long, rounded: corolla white, funnelform, expanding from the base upward, 3.5–4 cm. long, the limb 3–3.5 cm. broad with 5 slightly rounded lobes: capsules ovoid, exceeding the calyx; seeds lanate on the dorsal angles. (PLATE 2, FIGURE *a*.)

ST. THOMAS: *Eggers*, Feb., 1887 (type in herb. N. Y. Bot. Garden), January 14 and March 24, 1876; *266*, 1880 (in herb. Gray).

### 16. **Exogonium cubense** sp. nov.

A slender, perennial, twining vine, several m. high: stems woody below: leaf-blades ovate, or ovate-lanceolate, 3–8 cm. long, obtuse or subcordate at the base, entire or sinuately 3–5-lobed, middle lobe largest, lateral ones oblique and half as long; petioles shorter than the blades: peduncles 2–5 cm. long, 2–5-flowered; pedicels 10–15 mm. long: sepals unequal, the inner larger, ovate. obtuse, 8–10 mm. long and nearly as broad, the outer 5–6 mm, long: corolla white, about 5 cm. long, the tube 2–2.5 cm. long, thicker within the calyx than above, where it begins to expand into a funnelform or subsalverform limb 4–5 cm. broad and 5-lobed, the externally green plaits of the corolla ending in minute cusps at the margin. (PLATE 2, FIGURE *b*.)

CUBA: Gorge of the Yumuri, Matanzas, *Britton & Shafer 495*, March 20, 1903 (type in herb. N. Y. Bot. Garden).

This might be the *Ipomoea alterniflora* Griseb. as to all parts except the corolla, which is described as being purple, and an unnumbered specimen of Wright's so labeled in the Gray Herbarium is identical with *E. cubense*. All material of Wright's, other than this, labeled *I. alterniflora*, is *Ipomoea obtusata* Griseb. and it is evident that either the corolla was wrongly described in *I. alterniflora*, or what is more likely, considering the mixture of species under some of Wright's numbers, that the description of *I. alterniflora* represents two species, viz. *E. cubens* in part and *Ipomoea obtusata* as to the flowers.

17. EXOGONIUM ERIOSPERMUM (Desr.) Choisy, Conv. Rar. 130. 1837. — In DC. Prodr. 9: 347. 1845

*Convolvulus eriospermus* Desr. in Lam. Encyc. 3: 567. 1789.

*Ipomoea eriosperma* Raf. Fl. Tellur. 4: 74. 1838. — Urb. Symb. Ant. 3: 350. 1902. Not *I. eriosperma* Beauv. 1807.

*Ipomoea Desrousseauxii* Steud. Nom. ed. 2. 816. 1841.

TYPE LOCALITY: St. Domingo.

DISTRIBUTION: St. Domingo.

SPECIMENS EXAMINED: *Wright, Parry, & Brummel 378*, 1871 (in Nat. Herb.).

### 18. **Exogonium viridiflorum** (Urb.)

*Ipomoea virdiflora* Urb. Symb. Ant. **3**: 348. 1902.

Stems dark-red, striate, minutely pilose above: leaf-blades pedately divided, middle lobe 3–4 cm. long, 1.5–2.5 cm. broad; petioles 2–3 mm. long: peduncles 1–2 cm. long, 1–few-flowered: sepals obovate orbicular, 6 mm. long, the inner ones emarginate.

TYPE LOCALITY: Hayti.

DISTRIBUTION: Hayti.

### 19. **Exogonium leucaneurum** (Urb.)

*Ipomoea leuconeura* Urb. Symb. Ant. **3**: 350. 1902.

Prostrate or trailing: stems woody below, striate: leaf-blades digitately 7- (rarely 5- or 6-) divided segments 5–30 mm. long, attenuate below into petiolules 3 mm. long: peduncles 2–7 mm. long, 1–10-flowered; pedicels 7–12 mm. long: sepals green or tinged with red, unequal, outer 3.5 mm. long, inner narrowly ovate or obovate, 5 mm. long, rounded or emarginate: corolla scarlet, 35–45 mm. long, slightly inflated in the middle, the limb about 25 mm. broad: capsules oblong, 15 mm. high; seeds with a yellowish white coma of long reflexed hairs.

TYPE LOCALITY: Hayti.

DISTRIBUTION: Hayti. No specimens seen.

### 20. EXOGONIUM PEDATUM Choisy, Conv. Rar. 130. 1837.—In DC. Prodr. **9**: 347. 1845

Stems woody below, terete: leaf-blades pedate, lateral lobes 2-parted; segments petiolulate, narrowly lanceolate, obtuse, 1.5–3 cm. long, 4–7 mm. wide or less: peduncles 2–5 cm. long, 2–6-flowered: outer sepals slightly shorter than the inner, which are about 4 mm. long, oval: corolla red, 3.5–4.5 cm. long.

TYPE LOCALITY: St. Domingo.

DISTRIBUTION: Hayti and St. Domingo.

### SPECIES INQUIRENDAE

IPOMOEA RUBROCINCTA Urb. *l. c.* 347. Doubtfully distinct from *E. pedatum*, from the description, although no specimens have been seen.

IPOMOEA NEMATOLOBA Urb. *l. c.* 349. Stems plicate-striate: leaf-blades digitately divided into 5–7, obtuse, filiform segments, 35 mm. long by 0.5 mm. wide; petioles 3–9 mm. long: peduncles 1–3 mm. long: outer sepals oval, 3 mm. long, inner ones 3.5 mm. long, rounded at the apex: corolla white, tinged with green, the oval, subemarginate lobes of the limb 9–10 mm. long. Hayti.

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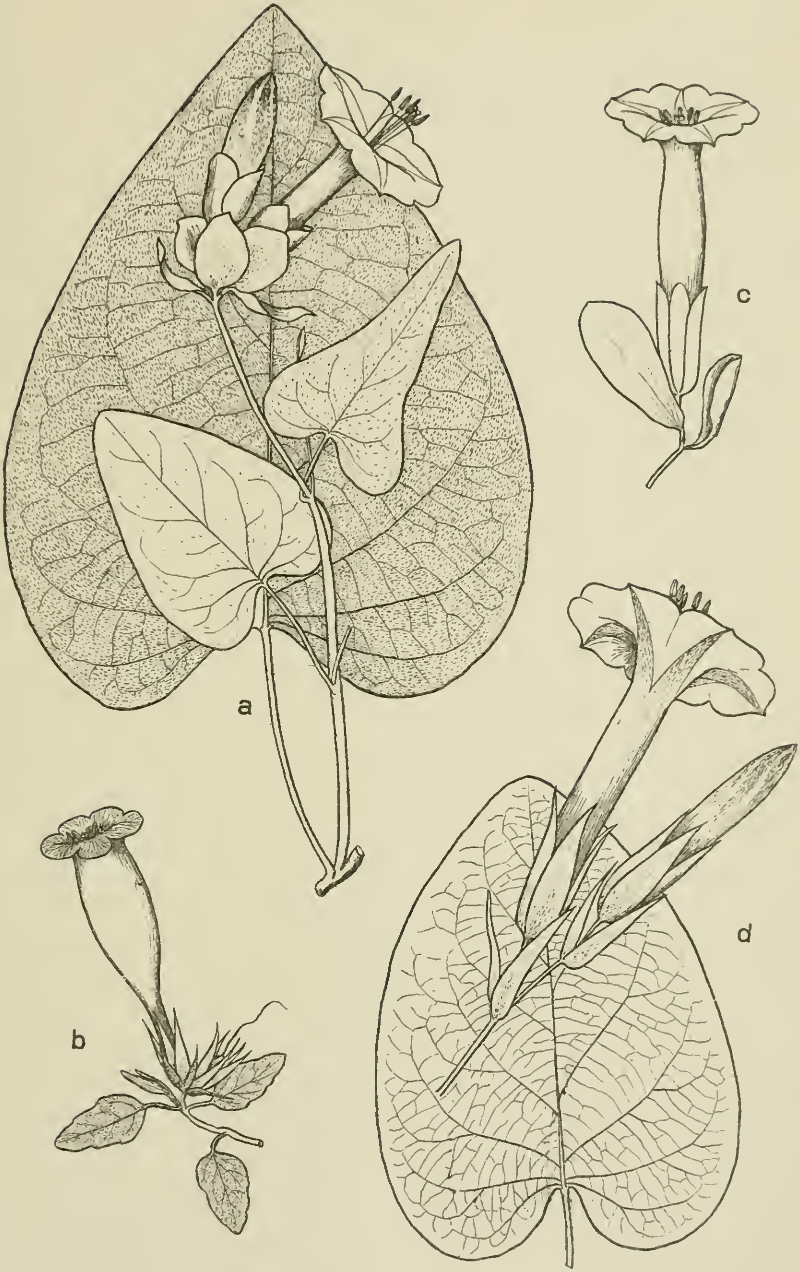
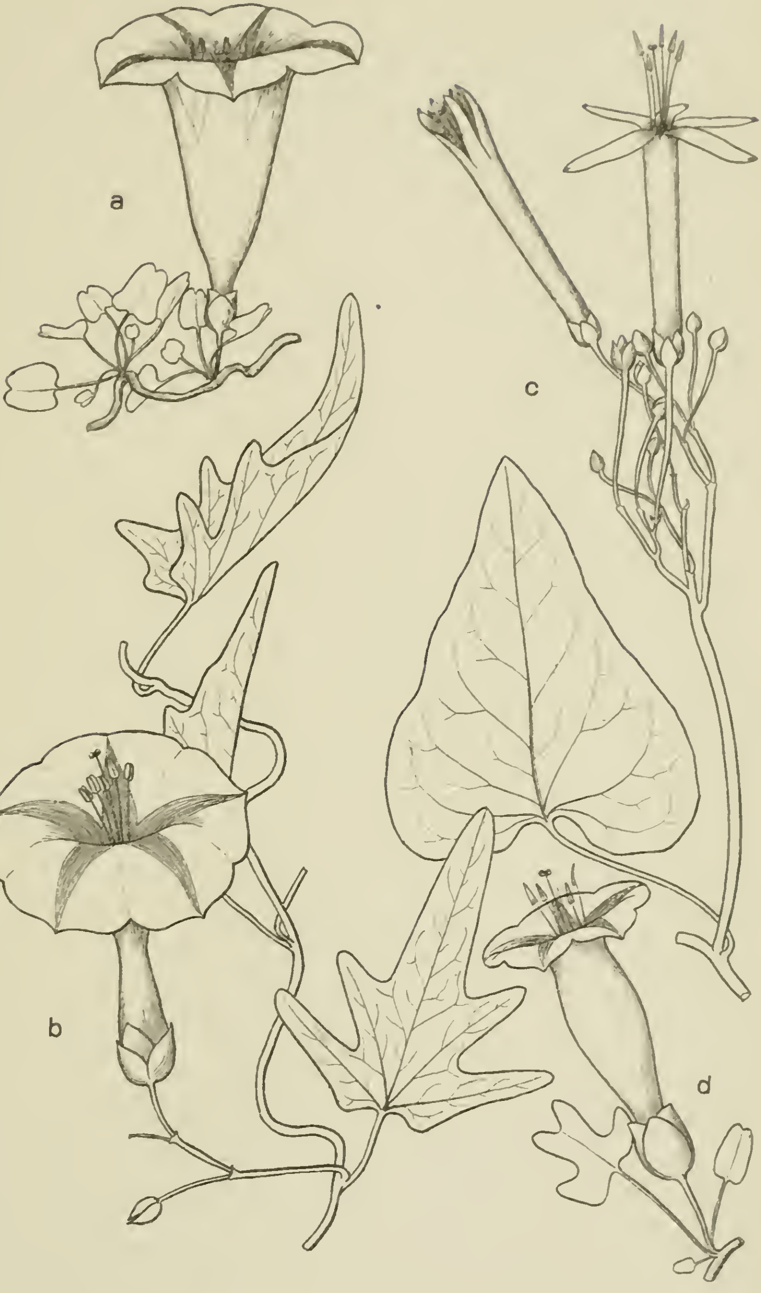


a. EXOGONIUM RUDOLPHII (Roem.& Schult.) House
b. EXOGONIUM VELUTIFOLIUM House
c. EXOGONIUM RACEMOSUM (Poir.) Choisy
d. EXOGONIUM WRIGHTII House



a. EXOGONIUM EGGERSII House
b. EXOGONIUM CUBENSE House
c. EXOGONIUM LUTEUM House
d. EXOGONIUM ARENARIUM Choisy

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# THE TAXONOMIC ASPECT OF THE SPECIES QUESTION

By NATHANIEL LORD BRITTON

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# THE TAXONOMIC ASPECT OF THE SPECIES QUESTION

DR. NATHANIEL LORD BRITTON

NEW YORK BOTANICAL GARDEN

## 1. HISTORIC

THE ancients knew and described plants by generic names. Their knowledge of them was general and superficial. According to Adanson,[1] Conrad Gesner, 1559, was the first to indicate the distinction of plants into genera and species, although this advance is also claimed for Columna. Subsequent authors in general, for about a century, arranged species of plants under generic names, but without definite rules for the limitations of genera. Morison (1655), Ray (1682), and Tournefort (1694), defined genera with reference to their fruits and were followed by Linnæus.

Ray regarded specific differences as those that are somewhat notable and fixed and not due to cultivation and which cultivation does not change. The way to determine these, according to him, is to grow them from seed, because all the differences which are found in different plants grown from the same seed are accidental and not specific, but he was not always exact in following this rule.

Tournefort declared that it troubled him very little whether the plants he cited were species or varieties as long as they differed in remarkable and perceptible qualities; Adanson approves this view, remarking that it seems to him sufficient and reasonable.

From Linnæus, Philosophia Botanica, 1751.

We enumerate as many species as different forms were originally created.

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[1] Fam. des Plantes 1: 102. 1763.

There are as many species as the Infinite Being originally produced different forms; and these forms, following the laws of reproduction imposed upon them, have produced more, but always similar to themselves. Therefore, there are as many species as there are different forms or structure met with to-day.

From Adanson, Familles des Plantes, 1763.

The moderns define a species of plant as a collection of several individuals which resemble each other perfectly, yet not in everything, but in the essential parts and qualities, without, however, giving attention to the differences caused in these individuals either by sex or accidental varieties.

According to Linnæus (Phil. bot., p. 99) "the species of plants are natural and constant, as their propagation either by seeds or cuttings is only a continuation of the same species. Individuals die, but the species does not."

But we wish to make a distinction between reproduction by seed and that by shoots, offsets, corms, cuttings, suckers or by grafting. These last simply continue the individual from which they are taken and consequently are opposed to the production of new species in plants; *whereas seeds are the source of a prodigious number of varieties, sometimes so changed that they may pass for new species.* He cites, among other examples:

"In 1715 Marchant found in his garden a new species of Mercurialis and the following year it came from self-sown seed; again, four resembled the parent and two were so different that he made another species of Mercurialis. These two new plants were cultivated and continued to grow each year."

It is well known that without foreign fecundation in plants that reproduce by seed, similar changes are induced either by reciprocal fecundation of two different individuals or owing to cultivation, the soil, the climate, dryness or moisture, light or shade, etc. These changes are more or less prompt, more or less durable, disappearing in one generation or perpetuating themselves through several generations, according to the number, the force, the duration of the causes which united to form them, etc., according to the nature, the disposition, the customs, so to speak, of each plant, for it is to be noted that some families do not vary except in the roots, others in the leaves, others in height, pubescence, and color, whereas others change more easily their flowers or their fruit.

It is difficult to define a primitive species and which those are which have originated by successive reproduction or been changed by accidental causes. It is without doubt for this reason that we do not find nowadays a number of plants described by ancient botanists; they have disappeared, either by returning to primitive forms or by changing their form in the multiplication of species. For this reason the ancients knew fewer species; time has brought novelties! And for the same reason future botanists will be *overwhelmed* by the number of species and be obliged to abandon them and be *reduced solely* to *genera!*

From Lamarck, Encyclopedie Methodique, Vol. 2, 1786.

*Species;* in botany as in zoology, a species is necessarily constituted of the aggregation of similar individuals which perpetuate themselves, the same, by reproduction. I understand similarity in the essential qualities of the species, because the individuals which constitute it offer frequently accidental differences which give rise to varieties and sometimes sexual differences, which belong however to the same species, as the male and female hemp, in which all the individuals constitute the common cultivated hemp. Thus, without the constant reproduction of similar individuals, there could not exist a true species.

From Rees, Abraham, The Cyclopædia, Vol. XXXIII, 1819.

Species *of Plants,* in *Systematic Botany,* appear, as far as can be ascertained from the universal experience of those who are conversant with them, as well as from everything that can be gathered from the records of remote antiquity, to remain distinct from each other, marked by their appropriate characters and qualities, and renewing themselves periodically by sexual generation. Such being the case with all the plants of which we have any knowledge, we conclude it to be so with the rest, as well as with animals. The white blackbird of Aristotle still inhabits the Cyllenian groves and copses of Arcadia, undisturbed by the revolutions of two thousand years; and we doubt not that the banks of the Alpheus have been fringed with the same violets and primroses, through uncounted ages, as those with which they are now, every spring, adorned.

Various plants indeed, and especially domestic ones, like domestic animals, are found liable to some variations of color, luxuriance, and sensible qualities, which have led curious inquirers to doubt whether any species are certainly permanent. This doubt could arise only from a slight view of the subject. Whatever casual aberrations there may be in the seminal offspring of cultivated plants, a little observation will prove how transient such varieties are, and how uniformly their descendants, if they be capable of producing any, resume the natural characters of the species to which they belong.

From A. P. DeCandolle and K. Sprengel, Elements of the Philosophy of Plants, Edinburgh, 1821.

By species we understand a number of plants, which agree with one another in invariable marks.

In this matter everything depends upon the idea of invariableness. When an organ, or a property of it, is changed neither by difference of soil, of climate, or of treatment, nor by continued breeding, this organ or property is said to be invariable. When, for instance, we have remarked during centuries, that the centifolia has always unarmed leafstalks, we say correctly, that this property of the centifolia is invariable.

This idea proceeds on the supposition that the species which we know have existed as long as the earth has had its present form. No doubt there were, in the preceding state of our globe, other species of plants, which have now perished, and the remains of which we still find in impressions in shale, slate-clay, and other flœtz rocks. Whether the present species, which often resemble these, have arisen from them; whether the great revolutions on the surface of the earth, which we read in the Book of Nature, contributed to these transitions—we know not. What we know is that from as early a time as the human race has left memorials of its existence upon the earth the separate species of plants have maintained the same properties invariably.

To be sure, we frequently speak of the transitions and crossings of species; and it can not be denied that something of this kind does occur, though without affecting the idea of species which we have proposed. We must, therefore, understand this difference.

We perceive the *Transitions of a Species,* when it loses or changes the properties, which we had considered as invariable in the character. Thus, it would be a transition, if we had stated as an invariable character of winter wheat (*Triticum hybernum*), that it was biennial, and had an ear without awns; and if we should remark, that by frequent reproduction, and by very different treatment, it began to assume awns, and, when sown in spring, came to maturity during the same summer.

But this shows only that our idea of the difference between the two kinds of grains had been incorrect; for it is the universal rule, that the character does not constitute the species, but the species the character. Species, then, only appear to undergo transitions, when we have considered an organ or a property as invariable which is not so.

All properties of plants which are subject to change, form either a subspecies or a variety. By the former we understand such forms as continue indeed during some reproductions, but at last, by a greater difference of soil, of climate, and of treatment, are either lost or changed. When the different cabbage species receive the same treatment in the same climate, they continue to be frequently reproduced, without changing their appearance. But we can not on this account maintain, that cauliflower would retain the same favorite form in very different climates, and under a complete change of treatment. It at last changes so much, that it can scarcely be distinguished from the common cabbage. This, therefore, is a subspecies. Varieties again do not retain their forms during reproduction. The variable colors —the very variable taste, and other properties of the kitchen vegetables, the ornamental plants, and the fruit-trees, show what varieties are; and the scientific botanist must therefore be particularly attentive to distinguish permanent species from the variable subspecies, degenerate plants and varieties.

To this discrimination belongs, above all things, a careful, continued, and unprejudiced observation of the whole vegetation of the same plant during its different ages, and amidst the most different circumstances which have an influence on it. When, for instance, in the common *Lotus corniculatus,* on whatever soil it may grow, we uniformly observe that it has a solid stem, even and erect divisions of the calyx, and expanded filaments, we must of necessity distinguish, as a particular species from it, another form which grows in bogs and in watery meadows, which has a much higher, and always hollow stalk, the divisions of its calyx spread out into a star-shape and hairy, and which has uniformly thin filaments; and we must name this latter species either *Lotus uliginosus* with Schkuhr, or *Lotus major* with Scopoli and Smith. As, on the other hand, the *Pimpinella Saxifraga* grows sometimes quite smooth, and sometimes in woods and shady meadows, considerably hairy; as it displays sometimes simple and small stem-leaves, sometimes half and even doubly pinnated leaves; and as these forms vary according to the situation of the plant and during reproduction, we can not regard these forms by any means as distinct species, but we must view them as corruptions.

We see, that, in order to decide respecting the idea of a species, an observation of many years, and of much accuracy, is often required; and that the cultivation of plants, from the most different climates, in botanical gardens, is in the highest degree necessary for their discrimination.

From Lindley, John, An Introduction to Botany, London, 1832.

A *species* is a union of individuals agreeing with each other in all essential characters of vegetation and fructification, capable of reproduction by seed without change, breeding freely together, and producing perfect seed from which a fertile progeny can be reared. Such are the true limits of a species; and if it were possible to try all plants by such a test, there would be no difficulty in fixing them, and determining what is species and what is variety. But, unfortunately, such is not the case. The manner in which individuals agree in their external characters is the only guide which can be followed in the greater part of plants. We do not often possess the means of ascertaining what the effect of sowing their seed or mixing the pollen of individuals would be; and, consequently, this test, which is the only sure one, is, in practice, seldom capable of being applied. The determination of what is a species, and what a variety, becomes therefore wholly dependent upon external characters, the power of duly appreciating which, as indicative of specific difference, is only to be obtained by experience, and is, in all cases, to a certain degree arbitrary. It is probable that, in the beginning, species only were formed; and that they have, since the creation, sported into varieties, by which the limits of the species themselves have now become greatly confounded. For example, it may be supposed that a rose, or a few species of rose, were originally created. In the course of time these have produced endless varieties, some of which, depending for a long series of ages upon permanent peculiarities of soil or climate, have been in a manner fixed, acquiring a constitution and physiognomy of their own. Such supposed varieties have again intermixed with each other, producing other forms, and so the operation has proceeded. But as it is impossible, at the present day, to determine which was the original or originals, from which all the roses of our own time have proceeded, or even whether they were produced in the manner I have assumed; and as the forms into which they divide are so peculiar as to render a classification of them indispensable to accuracy of language; it has become necessary to give names to certain of those forms, which are called species. Thus it seems that there are two sorts of species: the one, called natural species, determined by the definition given above; and the other, called botanical species, depending only upon the external character of the plant. The former have been ascertained to a very limited extent; of the latter nearly the whole of systematic botany consists. In this sense a species may be defined to be "an assemblage of individuals agreeing in all the essential characters of vegetation and fructification." Here the whole question lies with the word essential. What is an essential character of a species? This will generally depend upon a proneness to vary, or to be constant in particular characters, so that one class of characters may be essential in one genus, another class in another genus; and these points can be only determined by experience. Thus, in the genus Dahlia, the form of the leaves is found to be subject to great variation; the same species producing from seed, individuals, the form of whose leaves vary in a very striking manner; the form of the leaves is, therefore, in Dahlia, not a specific character. In like manner, in Rosa, the number of prickles, the surface of the fruit, or the surface of their leaves, and their serratures, are found to be generally fluctuating characters, and can not often be taken as essential to species. The determination of species is, therefore, in all respects, arbitrary, and must depend upon the discretion or experience of the botanist.

From Nicholson, Henry Alleyne, A Manual of Zoology, New York, 1876.

*Species.*—No term is more difficult to define than "species," and on no point are zoologists more divided than as to what should be understood by this word. Naturalists, in fact, are not yet agreed as to whether the term species expresses a real and permanent distinction, or whether it is to be regarded merely as a convenient, but not immutable, abstraction, the employment of which is necessitated by the requirements of classification.

By Buffon, "species" is defined as "a constant succession of individuals similar to and capable of reproducing each other."

DeCandolle defines species as an assemblage of all those individuals which resemble each other more than they do others, and are able to reproduce their like, doing so by the generative process, and in such a manner that they may be supposed by analogy to have all descended from a single being or a single pair.

M. de Quatrefages defines species as "an assemblage of individuals, more or less resembling one another, which are descended, or may be regarded as being descended, from a single primitive pair by an uninterrupted succession of families."

Müller defines species as "a living form, represented by individual beings, which reappears in the product of generation with certain invariable characters, and is constantly reproduced by the generative act of similar individuals."

According to Woodward, "all the specimens, or individuals, which are so much alike that we may reasonably believe them to have descended from a common stock, constitute a *species.*"

From the above definitions it will be at once evident that there are two leading ideas in the minds of zoologists when they employ the term species; one of these being a certain amount of resemblance between individuals, and the other being the proof that the individuals so resembling each other have descended from a single pair, or from pairs exactly similar to one another. The characters in which individuals must resemble one another in order to entitle them to be grouped in a separate species, according to Agassiz, "are only those determining size, proportion, color, habits and relations to surrounding circumstances and external objects."

On a closer examination, however, it will be found that these two leading ideas in the definition of species—external resemblance and community of descent—are both defective, and liable to break down if rigidly applied. Thus, there are in nature no assemblages of plants or animals, usually grouped together into a single species, the individuals of which *exactly* resemble one another in every point. Every naturalist is compelled to admit that the individuals which compose any so-called species, whether of plants or of animals, differ from one another to a greater or less extent, and in respects which may be regarded as more or less important. The existence of such individual differences is attested by the universal employment of the terms "varieties" and "races." Thus a "variety" comprises all those individuals which possess some distinctive peculiarity in common, but do not differ in other respects from another set of individuals sufficiently to entitle them to take rank as a separate species. A "race," again, is simply a permanent or "perpetuated" variety. The question, however, is this —How far may these differences amongst individuals obtain without necessitating their being placed in a separate species? In other words: How great is the amount of individual difference which is to be considered as merely "*varietal*," and at what exact point do these differences become of "*specific*" value? To this question no answer can be given, since it depends entirely upon the weight which different naturalists would attach to any given individual difference.[2] Distinctions which appear to one observer as sufficiently great to entitle the individuals possessing them to be grouped as a distinct species, by another are looked upon as simply of varietal value; and, in the nature of the case, it seems impossible to lay down any definite rules. To such an extent do individual differences sometimes exist in particular genera—termed "protean" or "polymorphic" genera—that the determination of the different species and varieties becomes an almost hopeless task.

The second point in the definition of species—namely, community of descent—is hardly in a more satisfactory condition, since the descent of any given series of individuals from a single pair, or from pairs exactly similar to one another, is at best but a probability, and is in no case capable of proof.

Upon the whole, then, it seems in the meanwhile safest to adopt a definition of species which implies no theory, and does not include the belief that the term necessarily expresses a fixed and permanent quantity. Species, therefore, may be defined as *an assemblage of individuals which resemble each other in their essential characters, are able, directly or indirectly, to produce fertile individuals, and which do not (as far as human observation goes) give rise to individuals which vary from the general type through more than certain definite limits.* The production of occasional monstrosities does not, of course, invalidate this definition.

From Gray, Asa, Structural Botany, Ed. 6, 1879.

Species in biological natural history is a chain or series of organisms of which the links or component individuals are parent and offspring. Objectively, a species is the totality of beings which have come from one stock, in virtue of that most general fact that likeness is transmitted from parent to progeny. Among the many definitions, that of A. L. Jussieu is one of the briefest and best, since it expresses the fundamental conception of a species, *i. e.,* the perennial succession of similar individuals perpetuated by generation.

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[2] As an example of this, it is sufficient to allude to the fact that hardly any two botanists agree as to the number of species of willows and brambles in the British Isles. What one observer classes as mere varieties, another regards as good and distinct species.

The two elements of species are: (1) community of origin; and, (2) similarity of the component individuals. But the degree of similarity is variable, and the fact of genetic relationship can seldom be established by observation or historical evidence. It is from the likeness that the naturalist ordinarily decides that such and such individuals belong to one species. Still the likeness is a consequence of the genetic relationship; so that the latter is the real foundation of species.

No two individuals are exactly alike; and offspring of the same stock may differ (or in their progeny may come to differ) strikingly in some particulars. So two or more forms which would have been regarded as wholly distinct are sometimes proved to be of one species by evidence of their common origin, or more commonly are inferred to be so from the observation of a series of intermediate forms which bridge over the differences. Only observation can inform us how much difference is compatible with a common origin. The general result of observation is that plants and animals breed true from generation to generation within certain somewhat indeterminate limits of variation; that those individuals which resemble each other within such limits interbreed freely, while those with wider differences do not. Hence, on the one hand, the naturalist recognizes *varieties* or differences within the species, and on the other *genera* and other superior associations, indicative of remoter relationship of the species themselves.

From Darwin, Origin of Species, new edition, from the sixth English edition, New York, p. 33, 1883.

No one definition has satisfied all naturalists; yet every naturalist knows vaguely what he means when he speaks of a species. . . . The term variety is almost equally difficult to define; but here community of descent is almost universally implied, though it can rarely be proved.

From Britton and Brown, Illustrated Flora **1**: VI., 1896.

A species is composed of all the individuals of a kind capable of continuous successive propagation among themselves.

From De Vries, Species and Varieties, p. 32, 1905, under Elementary Species in Nature.

"What are species?" Species are considered as the true units of nature by the vast majority of biologists. They have gained this high rank in our estimation principally through the influence of Linnæus. They have supplanted the genera which were the accepted units before Linnæus. They are now to be replaced, in their turn, by smaller types, for reasons which do not rest upon comparative studies but upon direct experimental evidence.

## 2. Discussion

Any method of evolution makes difficult the establishment as a general conclusion, that all the progeny of a species must belong to that species. The paleontologists have always faced this difficulty; their species have of necessity been assumptions, and theoretically, at least, if the complete representation of any line of descent could be assembled it would be seen at once that the whole series of forms were in some way connected. The induced mutation effected by MacDougal in *Raimannia odorata,* in which plants so different from their immediate parent as to appear, at least, specifically distinct from it, as compared with other feral species, is a notable addition to the difficulty of maintaining such a conclusion.

As long as species were generally understood to be relatively fixed in characters, their delimitation was relatively simple, but the general understanding that all living organisms are descended from others which were different from them has greatly complicated the subject.

Whether the evolution has been by imperceptible progressive modifications of structure, or by mutations, or by both methods, the result is essentially the same from the practical standpoints of taxonomy; from these standpoints, then, similarity of individuals must remain the consideration to which most weight will be given in taxonomic usage. It has been conclusively proved that many mutants and elementary species or races breed true in enough instances to establish the rule for at least a number of generations; this should not, however, in my opinion, admit them to the category of species, which, though necessarily difficult in delimitation, will still remain the practical taxonomic groups, recognizing, nevertheless, that they are made up of either relatively constant or of widely fluctuating elementary components, which, in turn, will presumably yield the species of future geologic ages.

The recognition of the existence of incipient or elementary species or races within the composition of species, explains, in large part, the multiplication of species and of groups of assumed lower rank, in many of the larger genera, nearly every taxonomist, except the most conservative, having taken more or less part in thus increasing the number of descriptions and of names. They have been variously denominated species, subspecies, varieties, subvarieties and forms, according to the point of view of the investigator.

Geographic distribution has been invoked as a very useful aid in determining the limits of species. It is a well-recognized fact that certain areas of the earth's surface. some large, some small, are characterized by types of plants which differ from those of other areas, either contiguous or widely separated, and, in cases where types inhabiting different areas so characterized are apparently similar, though different, their separation or isolation has been given weight in regarding them as specifically distinct. No doubt this is a rational course to pursue if it is not carried to extremes. The question whether the environments to which the ancestors of such types have been exposed have been the cause of their differentiation, or whether the elementary species have been perpetuated which were best adapted to the soil, climate or other features of the environments, is one of the most interesting of unsolved problems. That similar types have for the most part come from common ancestors we must regard as most probable, even if now inhabiting widely separated regions, segregated by the disappearance of related types in intervening space, being thus remnants of the more general distribution of the ancestral forms in earlier geologic eras.

Geographic distribution must, however, in cases of contiguous land districts, be cautiously used as a determining factor. There are many instances in which a species with certain well-marked characters in one region is, apparently, at least, completely connected through intermediate characters with what is readily regarded as a perfectly distinct species in another region. Instances of this kind are within the experience of every one who has given attention to geographic distribution of plants. I say this is apparently the case; the conclusion is based on long series of herbarium specimens and on field observations made over large areas of country. Neither of these methods of information is wholly satisfactory, because the herbarium series must necessarily be limited in the number of specimens, and also because the field observations have to be taken at different times and usually at widely separated intervals. Still, the consensus of opinion of plant geographers leans strongly to the existence of intermediate forms in intermediate regions.

Some of these are almost certainly hybrids, but it would not be safe for us to conclude that they all are. Some light has been thrown on this question by the growing of the extreme forms side by side, and more information can doubtless be thus obtained, the principal difficulty being that the environment of the one is often fatal to the other. A better method would be to grow the two apparent extremes within the natural environment of the apparent intermediates.

## 3. THE TAXONOMIC TREATMENT OF GROUPS ASSUMED TO BE OF LOWER RANK THAN SPECIES

There is perhaps no taxonomic subject on which greater diversity of opinion and practise exists than in the arrangement and nomenclature of groups of individuals not accorded full specific value. The relationships of these groups to the group assumed to constitute the species proper, and the nomenclature of these subsidiary groups, vary all the way from regarding them all as species, to regarding some of them as subspecies, some as varieties, some as subvarieties, others as forms, while even finer distinctions have been attempted, and elaborate monographs of many genera have been written in the attempt to express descriptively these interrelationships. It has been very evident that these described groups are of unequal value, some resembling the assumed typical group more, some less, and in a good many instances very little. The general result of these attempts to dissect nature has been embarrassing, because when a subsequent student takes up the group he is wholly unable to determine from any descriptions that can be written where any given individual would have been grouped by the previous author, unless he has access to the actual specimens which the previous author studied, and the subsequent student also finds that the examination of a large number of different individual specimens from those studied by his predecessor contains some which do not fully agree with any one of his predecessor's descriptions, or he finds that some of his specimens agree about as well with one of the groups recognized by the previous author as they do with another. This result shows conclusively that for practical taxonomic purposes it is not desirable to attempt to define a great many of these minor groups. The tendency has been brought about, I believe, by the instinct of many investigators that everything in nature must be named and described, but nothing is to be gained by permitting this laudable purpose to run to extremes.

It is evident, I think, that our taxonomy has been based on the fundamental error that the plant world is to be regarded as divisible into smaller and smaller groups, rather than following nature and proceeding on the theory that it is built up of greater and greater ones; the science should be synthetic rather than analytic. The synthetic theory will give our observation and experimentation a different significance and enable us to comprehend some of the phenomena now masked by the analytic method of attack.

If, as now seems more probable than a few years ago, species are made up of elementary species, or races, and that these are being increased by mutation, there can be no end to the number of such groups produced. As to the designation of these groups, I suggest that the term race be employed. This has long been used to designate what have been called self-perpetuating varieties, which appear to me to be identical with the present conception of elementary species, and its application may readily be widened. The term variety loses its significance, because it is usually quite impossible to tell how any given individual or group of individuals has arisen, or from which species it has sprung. The term form could be used instead of either race or elementary species, but it has had such a trivial significance in literature that race seems to be preferable. Subspecies implies divisibility, and is, therefore, an undesirable term.

In conclusion, I submit the following propositions:

1. The individual is the taxonomic unit, usually undesignated.

2. Similar individuals constitute a race.

For general taxonomic purposes races need not be designated; the conception and description of the species is broad enough to include all races of which it is composed. There will never be complete uniformity of agreement as to the distinction between races and species, any more than there will ever be complete agreement as to the limitations of genera. It is futile in science to attempt to lay down principles which interfere with individual judgments. For special purposes the races may be designated numerically, as, *Quercus alba,* race 2; *Œnothera biennis,* race 12; *Bursa Bursa-pastoris,* race 17; *Draba verna,* race 104. There are doubtless many instances where the species is composed of only one race, just as we have monotypic genera composed of but one species.

3. Similar races constitute a species, the species designated binomially.

4. Similar species constitute a genus, the genus designated monomially.

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# THE GENUS ERNODEA: A STUDY OF SPECIES AND RACES

BY NATHANIEL LORD BRITTON

NEW YORK
1908

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# The genus Ernodea Swartz: a study of species and races*

Nathaniel Lord Britton

This genus of Rubiaceae was established by Swartz† on a single species, *E. littoralis* Sw., from the island of Jamaica. It has recently been regarded as monotypic, consisting only of the type species, which is widely distributed in the Caribbean region, in Jamaica, Florida, the Bahamas, and from Santo Domingo to Guadeloupe. I do not find the genus reported from Cuba, though it almost certainly exists there and further exploration will probably reveal it. Attempts have been made to refer to *Ernodea* plants now relegated to the genus *Putoria* of the Old World and to *Isidorea* of the West Indies.

In 1905 Dr. Small characterized *Ernodea angusta*‡ from pinelands in southern Florida, and in the same year I described *Ernodea Cokeri*§ found among the collections made by Professor Coker on Abaco Island during the Bahamian exploration organized by the Geographical Society of Baltimore. The Bahamian explorations conducted by the New York Botanical Garden and the Field Museum of Natural History have revealed the existence in the Bahamas of several additional species with apparently numerous races, the genus evidently having its greatest development in these islands. These explorations have afforded convenient opportunity for field study of the plants.

The shrubs form colonies sometimes of large size, spreading from underground parts so as to clothe densely the sand or rocks on which they grow. So far as our observation goes, they are confined to limestone rocks or limestone sand. That mutation takes place freely is indicated by the fact that in the Bahamas, at least, one colony will often differ from another near by in some minor character, such as leaf-form, tint of the corolla, prostrate or bushy habit. That such small characters are transmittable by seed is also evidenced by plants with identical features forming colonies at some distance from each other, and too far apart to have been produced by underground connection. The small fleshy yellow fruits of these plants are probably freely distributed by birds.

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* This treatment of a genus will serve to illustrate the propositions advanced by the writer in the symposium on "Aspects of the Species Question," at the meeting of the Botanical Society of America, Chicago, January, 1908.

† Prodr. 29. 1788.

‡ Bull. N. Y. Bot. Gard. 3: 438.

§ In Shattuck, The Bahama Islands, 264, Botany by W. C. Coker.

The numerous specimens now in the herbarium of the New York Botanical Garden seem to me to fall into six species, composed of a considerable number of races. Characters taken as specific are indicated by the following key :

- Calyx-lobes varying from nearly as long as the fruit to longer.
  - Leaves lanceolate to oblong, oblanceolate or oblong-lanceolate, 5–10 mm. wide.
    - Corolla white to pink; leaves relatively broad; plant mostly of coasts. 1. *E. littoralis.*
    - Corolla red to scarlet; leaves relatively narrow; plant mostly of pine-lands. 2. *E. angusta.*
  - Leaves narrowly linear, 1–3 mm. wide. 3. *E. Cokeri.*
- Calyx-lobes much shorter than the fruit.
  - Leaves oblong-lanceolate, 6–8 mm. wide. 4. *E. Millspaughii.*
  - Leaves narrowly linear to linear-oblanceolate, 1–3 mm. wide.
    - Leaves bristle-tipped; calyx-lobes half as long as the fruit. 5. *E. Taylori.*
    - Leaves merely mucronate; calyx-lobes one third as long as the fruit. 6. *E. Nashii.*

### 1. ERNODEA LITTORALIS Sw. Prodr. 29. 1788

The first mention and illustration of this type species of the genus was by Sir Hans Sloane in his Natural History of Jamaica, where he denominated it "Thymelaea humilior foliis acutis atrovirentibus" and illustrated it on his plate 189, figs. 1 and 2. By Patrick Browne, in History of Jamaica 140, it was referred to *Knoxia*, an East Indian genus established by Linnaeus in 1753. Jamaica is therefore the type locality of the species. I observed this plant, in company with Mr. William Harris, in September, 1907, at two points on the southern coast of Jamaica, where it grows prostrate on limestone rocks and sand. It has narrowly oblong to oblong-lanceolate entire sharp-pointed leaves, 4–8 mm. wide, the subulate stipules about 1.5 mm. long; the linear-lanceolate calyx-lobes are here just about as long as the fruit, but they evidently vary from somewhat shorter to somewhat longer. The distribution of this typical race is illustrated by the specimens cited as follows:

JAMAICA: Pedro Bluff (*Britton 1247; Harris 9719*); coastal rocks, near Black River (*Britton 1365*); rocky hillside, Great Goat Island (*Britton 1884*).

FLORIDA: Key West (*Blodgett*); Sarasota Keys (*Garber*); Indian River (*Curtiss 1117*); Sugar Loaf Key (*Pollard, Collins, & Morris 54*); Longboat Key (*Tracy 6752, 7496*); Miami (*Small & Nash 27*); Bull Key (*Small 629*); Virginia Key (*Britton 109*); beach opposite Miami (*Small 2152*); pinelands, Miami (*Britton 462*).

BAHAMAS: Great Bahama (*Britton & Millspaugh 2373, 2707*); Abaco (*Brace 1806; E. angusta* Small?); Andros (*Brace 6770*); Harbour Island (*Mrs. Britton 6380, 6414*); Eleuthera (*Britton & Millspaugh 5410*); Crooked Island (*Brace 4606, 4624*); Long Cay (*Brace 4069*); Acklin's Island (*Brace 4282*); Rum Cay (*Brace 3943*); Green Cay (*Coker 244*); Mariguana (*P. Wilson 7456*); Great Ragged Island (*P. Wilson 7880*).

SANTO DOMINGO: (*Wright, Parry, & Brummel 220*).

PORTO RICO: Sand dunes, Santurce (*Heller 64; Millspaugh 266*); Mayagüez to Joyua (*Underwood & Griggs 185*); Island of Culebra (*Britton & Wheeler 205*).

ST. CROIX: (*Hansen 155*).

GUADELOUPE: Calcareous rocks, Desirade (*Duss 2772*).

*Race 1.* Leaves narrowly linear-oblong, glandular-serrulate; twigs glabrous; calyx-lobes as long as the fruit or a little longer.

BAHAMAS: Cockburn Town, Watling's Island (*Britton & Millspaugh 6075*, type; *P. Wilson 7210*).

*Race 2.* Leaves broadly linear-oblong, 8–10 mm. wide, glandular-serrulate; calyx-lobes a little longer than the fruit. Shrub 1.3–1.6 m. high!

BAHAMAS: Miner's Tent to Balsam Hill, Inagua (*Nash & Taylor 1274*). This is the most vigorous development of the genus that has come to my attention, and has claims for recognition as a species.

*Race 3.* Leaves essentially of the typical race, but glandular-serrulate; twigs densely glandular-puberulent; calyx-lobes long.

BAHAMAS: Blakesville, Inagua (*Nash & Taylor 1105*). The specimen is in flower.

*Race 4.* Leaves large, lanceolate or oblong-lanceolate, tapering upward from below the middle, 6 cm. long, 1 cm. wide, entire-margined; calyx-lobes a little longer than the fruit.

BAHAMAS: Swamp, road to Stopper Hill, Crooked Island (*Brace 4807*). This is the only specimen known to me to grow in swampy ground.

*Race 5.* Leaves relatively thin, linear-oblong, entire-margined; calyx-lobes very narrow, 1.5 times as long as the fruit.

ST. CROIX: Pinetree Bay (*A. E. Ricksecker 333*, type).

PORTO RICO: Limestone hills three miles west of Ponce (*Heller 6243*).

There is no doubt that if plants here included in the typical race could be grown from seed, side by side, additional races to those here defined would be indicated by differences which herbarium specimens do not exhibit.

The typical race usually grows within the reach of ocean spray, accompanied by distinctively halophytic plants.

### 2. ERNODEA ANGUSTA Small, Bull. N. Y. Bot. Gard. 3: 438. 1905

This pine-barren plant of southern Florida was proposed by Dr. Small as a species distinct from *E. littoralis* on account of its smaller flowers and narrower leaves. He described the flowers as whitish; they are pink or red, though the albino condition may, likely enough, exist. My observations do not bear out the original observation that the flowers are necessarily smaller than those of *E. littoralis*, and plants of that species sometimes bear leaves as narrow as those of Dr. Small's type specimen, while red-flowered plants existing on the northern Bahama islands, while mostly narrow-leaved, like the type, sometimes bear broader leaves. It is an interesting circumstance that plants conforming to the type in both characters occur throughout the area of *Pinus caribaea* Morelet in South Florida and the northern Bahamas, almost though not quite to the exclusion of typical *E. littoralis*, as though the pine-land condition suited *E. angusta*, considered either as a species or as a race of *E. littoralis;* this is an ecological feature of extreme interest, especially as there are a number of other species or races which give character to these pine-lands. *E. angusta* apparently extends to the coasts where pine-lands are near by, or where pine trees formerly grew. The following specimens have been examined:

FLORIDA: Between Cutler and Longview Camp (*Small 870*); below Cutler (*S. H. Richmond*); beach opposite Miami (*Small 2157*); near Silver Palm School (*Small 2260*); near Long Prairie (*Britton 191*); Boca Grande Key, Marquesas Group (*Lansing 2276; E. littoralis?*).

BAHAMAS: New Providence (*Northrop 102; Cooper 58; Coker 63; Britton & Millspaugh 2099*); Andros (*Brace 4958, 5120, 5167, 5319, 6867, 6993, 7084*).

*Race 1.* Leaves relatively twice as wide as in the typical race; corolla bright-scarlet. This inhabits Garden Cay at the western end of the Great Bahama Island (*Brace 3662*); it may be better regarded as a scarlet-flowered race of *E. littoralis.*

3. ERNODEA COKERI Britton; Coker in Shattuck, The Bahama Islands 264. 1905

Occurring at the northern and northeastern range of the genus, this species exhibits the narrowest leaves of any, these being mostly only 1.5 mm. wide or less. So far as known it is confined to Abaco and the Great Bahama, growing in pine-lands and in scrub-lands where pines evidently formerly existed. Its flowers are apparently red or pink. I have seen the plant growing on the Great Bahama Island, but not in bloom; its aspect and habit are very characteristic there, it forming a trailing vine, a meter long or more.

BAHAMAS: Abaco (*Coker 564; Brace 1805, 1821*); Great Bahama (*Britton & Millspaugh 2370*).

*Race 1.* Leaves twice as wide as typical, approaching in size and form those of *E. angusta.* On sand dunes, Barnett's Point, Great Bahama (*Britton & Millspaugh 2681*).

### 4. **Ernodea Millspaughii** sp. nov.

A shrub, 6–12 dm. high, the twigs and leaves glabrous. Leaves oblong-oblanceolate, sharply pointed, 2–3 cm. long, 5–8 mm. wide, similar to those of *E. littoralis*, the short broad stipules cuspidate; flowering calyx obovoid, about 3 mm. long, the triangular lobes only one fifth to one fourth as long as the ovary; corolla white, 1 cm. long, its lobes about one half as long as the tube; fruit nearly oval, 5 mm. long, the calyx-lobes triangular-lanceolate, 1.5–2 mm. long.

BAHAMAS: Sand dunes, Clarence Town, Long Island, March 16–19, 1907 (*Britton & Millspaugh 6249*, type); Grand Turk (*Nash & Taylor 3801*). The Grand Turk specimens differ from the type in having calyx-lobes a little longer and narrower and approach the plant of Great Ragged Island (*P. Wilson 7880*), *E. littoralis.* This might be regarded as a race of *E. littoralis* with short calyx-lobes.

### 5. **Ernodea Taylori** sp. nov.

Spreading, with long slender branches, glabrous. Leaves narrowly linear, stiff, 1.5–2.5 cm. long, 1.5–2 mm. wide, revolute-margined, spinulose-tipped, the stipules triangular-subulate; flowers not seen; fruit golden-yellow, oval, 5 mm. long, the calyx-lobes narrowly linear, 2 mm. long.

BAHAMAS: In white land, Tenados, Inagua, Oct. 14, 1904 (*Nash & Taylor 1024*).

The foliage resembles that of *E. Cokeri*, but the calyx is altogether different.

### 6. **Ernodea Nashii** sp. nov.

Prostrate, glabrous throughout, the branches 6 dm. long or more, the branchlets erect or ascending, 0.5–2 dm. high, the twigs very densely clothed with leaves. Leaves linear-oblanceolate, leathery in texture, 2–2.5 cm. long, 2–3 mm. wide, mucronulate; flowering calyx 4.5 mm. long, its lobes acute, 1.5 mm. long; corolla 1.5 cm. long, its lobes white within, brown without, about one third as long as the tube; fruit ovoid-oval, 5 mm. long, the persistent acute calyx-lobes 1.5 mm. long.

BAHAMAS: Little Inagua, Moujean Harbor (*Nash & Taylor 1193*, type); west end of Little Inagua (*P. Wilson 7782*).

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# FURTHER STUDIES OF SOLUTION TENSION AND TOXICITY IN LIPOLYSIS

By RAYMOND H. POND

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# FURTHER STUDIES OF SOLUTION TENSION AND TOXICITY IN LIPOLYSIS[1]

RAYMOND H. POND

This paper is really a continuation of an earlier one[2] which supplied data showing that the toxicity of certain salts in lipolysis does not vary inversely as the decomposition tension of those salts. As my conclusion disagrees with that of MATHEWS,[3] MCGUIGAN,[4] and CALDWELL,[5] and as BERG and GIES[6] found that the nature of the zymolyte is an important factor in peptolysis and tryptolysis, it seemed desirable to determine whether the same general relation found by me for the toxicity of several nitrates in the lipolysis of ethyl butyrate would also hold in the case of some other ester. Ethyl acetate was selected as the zymolyte because its saponification is a monomolecular reaction, because acetic acid is a close homologue of butyric acid, and because LOEVENHART and PEIRCE[7] found that the hydrolysis of ethyl acetate is inhibited to a greater extent by sodium fluorid than that of ethyl butyrate. They also expressed the view that the inhibiting effect of sodium fluorid is dependent upon the acid radical from which the ester is derived, while the alcohol arising in the saponification is a comparatively indifferent factor.

Since the same general procedure has been followed here as in the preceding investigation, many of the details given before will be omitted here. Most of the solutions used were made up from the same stock solutions and all were upon the same basis of molecular weight. The lipase used was taken from the same sample. Professor GIES has been my counselor in this work as in the other, and the same acknowledgments are due the New York Botanical Garden for the exceptionally favorable facilities afforded.

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[1] From the laboratories of the New York Botanical Garden.

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[5] CALDWELL, J. S., The effects of toxic agents upon the action of bromelin. BOT. GAZETTE 39:409–419. 1905.

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## METHOD

When ethyl acetate is decomposed by the action of lipase, the products are supposed to be the same as in any case of its saponification, namely, acetic acid and ethyl alcohol. The amount of acid liberated from initially neutral acetate under given conditions is an index of the amount of enzyme activity under those conditions, and can be expressed in cubic centimeters of KOH solution required for neutralization. Since boiling destroys the activity of the enzyme, and since the acetate does not become appreciably acid in such a boiled solution of the enzyme during an incubation of 5 hours at 40° C., a boiled solution of the enzyme can be used as a control. The difference then in acidity of a boiled and of an unboiled solution of the enzyme of equal concentration, to which the same amount of ester has been added, expresses the amount of enzyme activity under the conditions imposed. Six vials were used for each concentration of the toxic salt. To each vial were added $2^{cc}$ of the toxic salt solution of a certain concentration, say $m/32$. Then to each of three of the vials were added $2^{cc}$ of the unboiled, filtered enzyme solution having a given concentration, say 0.10 per cent. To each of the other three vials were then added $2^{cc}$ of a portion of the same enzyme solution which had been boiled. Then to each of the six vials was added $0.10^{cc}$ of neutral ethyl acetate free from alcohol. The stoppered vials were placed in an incubator for 5 hours at 40°C. After incubation each vial was titrated with $m/40$ KOH, using phenolphthalein as an indicator. The difference between the boiled and unboiled solutions showed the amount of enzyme activity for $m/64$ of the salt used with a concentration of the enzyme of about 0.05 per cent. Filtering the enzyme solution makes the exact concentration uncertain. All of the salts used were nitrates except that of mercury, which was the bichlorid.

Since the acetate has the lower boiling-point and decomposes more rapidly in the presence of water, one would expect that it would be more readily saponified by the lipase. A 0.0125 per cent. solution of the enzyme yielded from 0.10$^{cc}$ of butyrate enough acid to require 0.20$^{cc}$ of $m/20$ KOH for neutralization. The same concentration of enzyme acting for one hour longer at the same temperature on the same amount of acetate gave the figure 0.06$^{cc}$ of $m/40$ KOH. A stronger solution of the enzyme (0.0250 per cent.) acting on the acetate gave 0.08$^{cc}$ of $m/40$ KOH. From this one might think that the butyrate is the less stable in the presence of the enzyme, but it may be that the products of saponification are more inhibiting in the one case than in the other. The concentration of the enzyme in most of

TABLE I: RELATIVE TOXICITY WITH SAME CONCENTRATION OF ENZYME

*Potassium and sodium in contemporaneous test*

POTASSIUM

| *m* | Control[8] | Enzyme[8] | Increase[8] |
|---|---|---|---|
| Water[8] | 0.07 | 0.25 | 0.18 |
| 32 | 0.06 | 0.20 | 0.14 |
| 16 | 0.06 | 0.19 | 0.13 |
| 8 | 0.06 | 0.16 | 0.10 |
| 4 | 0.06 | 0.13 | 0.07 |
| 2 | 0.06 | 0.13 | 0.07 |
| 1 | 0.06 | 0.10 | 0.04 |

SODIUM

| *m* | Control[8] | Enzyme[8] | Increase[8] |
|---|---|---|---|
| 32 | 0.07 | 0.20 | 0.13 |
| 16 | 0.07 | 0.17 | 0.10 |
| 8 | 0.07 | 0.15 | 0.08 |
| 4 | 0.07 | 0.13 | 0.06 |
| 2 | 0.07 | 0.10 | 0.03 |
| 1 | 0.07 | 0.10 | 0.03 |

Enzyme 0.05 per cent. Incubation 5 hours at 40° C.

[8] In the column headed "*m*" are given the various concentrations of the toxic salt in fractions of molecular strength. In this column the word "Water" means that 2$^{cc}$ of water were used instead of the toxic solution in order to ascertain the uninhibited activity of the enzyme in 0.05 per cent. strength. In the column headed "Control" are given the figures for the final acidity (cc. $m/40$ KOH) of the boiled preparations containing the toxic salt in the concentration indicated by the corresponding figure in the column headed "*m*." The column headed "Enzyme" shows the final acidity of the unboiled preparations corresponding to the controls. The column headed "Increase" shows the difference in acidity between the controls and the unboiled preparations and expresses the amount of saponification allowed by the concentration of the toxic solution indicated by the corresponding figures in the column headed "*m*."

the tests was 0.05 per cent., that is, the filtrate obtained from the solution of $0.20^{\text{gm}}$ of the enzyme powder in $200^{\text{cc}}$ of water, filtered and then diluted one-half by the addition of an equal volume of the toxic solution. During 5 hours' incubation at 40° C., $0.1^{\text{cc}}$ of neutral acetate in $4^{\text{cc}}$ of water remains neutral.

In this test, as in several that follow, it was observed that while there was sediment in each of the vials containing boiled enzyme, the vials containing the unboiled solutions were at the close of the incubation entirely clear and free from sediment. There is no doubt therefore that partial inhibition of the enzyme is possible and actually occurs in the absence of any precipitation whatever. In this table we note that the uninhibited activity of the enzyme is expressed by $0.18^{\text{cc}}$. The most concentrated solutions of the salts reduce this to 0.04 for potassium and to 0.03 for sodium. The amount of inhibition is therefore very considerable, and yet there was no precipitation even after an incubation period of 5 hours at 40° C. In this test the nitrates of sodium and of potassium are certainly to be regarded as equitoxic.

TABLE II: *Potassium, sodium, and lithium in contemporaneous test*

POTASSIUM

| *m* | Control | Enzyme | Increase |
|---|---|---|---|
| Water | 0.10 | 0.25 | 0.15 |
| 8 | 0.10 | 0.15 | 0.05 |
| 4 | 0.10 | 0.13 | 0.03 |
| 1 | 0.10 | 0.13 | 0.03 |
| **SODIUM** | | | |
| 8 | 0.10 | 0.20 | 0.10 |
| 4 | 0.08 | 0.16 | 0.08 |
| 2 | 0.07 | 0.15 | 0.08 |
| 1 | 0.07 | 0.12 | 0.05 |
| **LITHIUM** | | | |
| 8 | 0.08 | 0.17 | 0.09 |
| 4 | 0.09 | 0.15 | 0.06 |
| 2 | 0.09 | 0.13 | 0.04 |

Enzyme 0.05 per cent. Incubation 4 hours at 45 C.

So far as this particular test is concerned, it can hardly be said that the salts are equitoxic. On the other hand, it cannot be positively concluded which of the three is the most toxic. Comparison of the individuals of the series leads to nothing decisive. The next table shows that fluctuating differences occur.

TABLE III

POTASSIUM

| *m* | Control | Enzyme | Increase |
|---|---|---|---|
| Water | 0.09 | 0.23 | 0.14 |
| 8 | 0.10 | 0.20 | 0.10 |
| 4 | 0.09 | 0.18 | 0.09 |
| 2 | 0.09 | 0.16 | 0.07 |
| 1 | 0.09 | 0.12 | 0.03 |

SODIUM

| *m* | Control | Enzyme | Increase |
|---|---|---|---|
| 8 | 0.07 | 0.20 | 0.13 |
| 4 | 0.08 | 0.18 | 0.10 |
| 2 | 0.08 | 0.15 | 0.07 |
| 1 | 0.08 | 0.13 | 0.05 |

LITHIUM

| *m* | Control | Enzyme | Increase |
|---|---|---|---|
| 8 | 0.10 | 0.17 | 0.07 |
| 4 | 0.09 | 0.16 | 0.07 |
| 2 | 0.09 | 0.13 | 0.04 |

Enzyme 0.05 per cent. Incubation 5 hours at 45° C.

There seems to be some indication that lithium is more toxic than sodium or potassium, but the difference is too insignificant for a conclusion. In all the vials the unboiled solutions were free from sediment. Since the salt solutions themselves are neutral in all the concentrations tried, the column showing acidity of the reagent has been omitted. The titration with the *m*/40 KOH instead of the *m*/20 KOH used in the previous investigation with ethyl butyrate perhaps brings out greater variations. The acidity of the control is usually with each of these salts about the same in all concentrations and just about what the plain enzyme solution itself is. This confirms the observation made in the work with ethyl butyrate that there is no positive sign of any chemical action between the substance of the enzyme solution and that of the toxic solution.

In this test the two salts are neutral in all concentrations tried. One drop of the *m*/40 KOH gives a deep purple with $4^{cc}$ of the salt solution in any of the concentrations used in the test. The unboiled preparations were all free from sediment after incubation. Total inhi-

TABLE IV: *Barium and magnesium in contemporaneous test*

| *m* | Control | Enzyme | Increase |
|---|---|---|---|
| | | **BARIUM** | |
| Water | 0.10 | 0.22 | 0.12 |
| 128 | 0.10 | 0.22 | 0.12 |
| 64 | 0.10 | 0.20 | 0.10 |
| 32 | 0.10 | 0.18 | 0.08 |
| 16 | 0.10 | 0.17 | 0.07 |
| 8 | 0.10 | 0.16 | 0.06 |
| | | **MAGNESIUM** | |
| 128 | 0.10 | 0.22 | 0.12 |
| 64 | 0.10 | 0.20 | 0.10 |
| 32 | 0.10 | 0.18 | 0.08 |
| 16 | 0.10 | 0.17 | 0.07 |
| 8 | 0.10 | 0.16 | 0.06 |

Enzyme 0.05 per cent. Incubation 4.5 hours at 40° C.

bition seems to be impossible for this concentration of the enzyme as *m*/4 of the salts is almost saturation at room temperature. In this test the two salts are certainly equitoxic.

TABLE V: *Barium and strontium in contemporaneous test*

| *m* | Control | Enzyme | Increase |
|---|---|---|---|
| | | **BARIUM** | |
| Water | 0.13 | 0.27 | 0.14 |
| 128 | 0.13 | 0.27 | 0.14 |
| 64 | 0.13 | 0.24 | 0.11 |
| 32 | 0.13 | 0.22 | 0.09 |
| 16 | 0.13 | 0.20 | 0.07 |
| 8 | 0.13 | 0.16 | 0.03 |
| | | **STRONTIUM** | |
| 128 | 0.13 | 0.27 | 0.14 |
| 64 | 0.13 | 0.24 | 0.11 |
| 32 | 0.13 | 0.22 | 0.09 |
| 16 | 0.13 | 0.20 | 0.07 |
| 8 | 0.13 | 0.16 | 0.~~07~~ 03 |

Enzyme 0.05 per cent. Incubation 5 hours at 40° C.

In this test the two salts are certainly equitoxic. Comparison with Table IV however shows inconstancy. Thus, *m*/8 of barium in Table IV allows 0.06 as compared with 0.03 in Table V. On the other hand, in both cases, *m*/128 of barium allows uninhibited activity. Again, the figure indicating full activity in Table IV is less than that in Table V, and yet *m*/8 barium inhibits more in the latter than in the former. It is of course simply a matter of judgment how such results are to be interpreted. Since barium and strontium are equitoxic in contemporaneous tests and since the same is true of barium and magnesium, it is reasonable to conclude that the three salts are equitoxic. This same relation was found in the case of ethyl butyrate. In this table (V) the control figure is higher than that in Table IV. There is, however, a corresponding increase in the figures in the enzyme column. Just what causes such fluctuation from day to day is difficult to tell, but there seems to be sufficient uniformity in the test as a whole. For the sake of assurance another test was made, and this gave practically identical figures with those in Table IV. The figure for *m*/8 barium shows some irregularity in this next table.

TABLE VI: *Barium and magnesium in contemporaneous test*

BARIUM

| *m* | Control | Enzyme | Increase |
|---|---|---|---|
| Water | 0.10 | 0.23 | 0.13 |
| 128 | 0.10 | 0.22 | 0.12 |
| 64 | 0.10 | 0.20 | 0.10 |
| 32 | 0.10 | 0.17 | 0.07 |
| 16 | 0.10 | 0.16 | 0.06 |
| 8 | 0.10 | 0.13 | 0.03 |

MAGNESIUM

| *m* | Control | Enzyme | Increase |
|---|---|---|---|
| 128 | 0.10 | 0.22 | 0.12 |
| 64 | 0.10 | 0.20 | 0.10 |
| 32 | 0.10 | 0.18 | 0.08 |
| 16 | 0.10 | 0.16 | 0.06 |
| 8 | 0.10 | 0.16 | 0.06 |

Enzyme 0.05 per cent. Incubation 5 hours at 40 C.

In the work with ethyl butyrate I found barium, strontium, and magnesium to be equitoxic with each other, but all were more toxic than either sodium, potassium, or lithium, which latter were equitoxic with each other. In the foregoing tables there are some indications that barium, strontium, and magnesium are more toxic than the sodium, potassium, lithium group. On the other hand, the differences between lithium and magnesium are not so great. Thus, *m*/8 of lithium in Table II allows 0.09, while *m*/16 of magnesium in Table IV allows 0.07. Again, *m*/8 of lithium in Table III allows 0.07. From the foregoing tables it would be impossible to say that the barium group is more toxic than the sodium group on the equinormal basis.

It may be that the zymolyte ethyl acetate tends to minimize the difference in relative toxicity as compared with the zymolyte ethyl butyrate. While this is a plausible explanation, it has little value in the absence of convincing evidence, and we cannot select the determining factor. Why the variations in the different tests should be relatively so wide is not understood, especially in view of the precautions to avoid error.[9] The following test shows that barium is more toxic than lithium under the same conditions as imposed in a contemporaneous test. This emphasizes the apparent tendency of the barium group to exceed the sodium group in toxicity, and such a conclusion is perhaps permissible in view of all the results of this work and that on ethyl butyrate; but it would certainly be difficult to say how much more toxic.

TABLE VII: *Barium and lithium in contemporaneous test*

BARIUM

| *m* | Control | Enzyme | Increase |
|---|---|---|---|
| Water | 0.10 | 0.20 | 0.10 |
| 256 | 0.09 | 0.16 | 0.07 |
| 128 | 0.09 | 0.15 | 0.06 |
| 64 | 0.09 | 0.15 | 0.06 |
| 32 | 0.10 | 0.13 | 0.03 |
| 16 | 0.10 | 0.12 | 0.02 |
| 8 | 0.10 | 0.10 | 0.00 |

LITHIUM

| *m* | Control | Enzyme | Increase |
|---|---|---|---|
| 64 | 0.10 | 0.20 | 0.10 |
| 32 | 0.10 | 0.18 | 0.08 |
| 16 | 0.10 | 0.17 | 0.07 |
| 8 | 0.10 | 0.12 | 0.02 |
| 4 | 0.10 | 0.11 | 0.01 |
| 2 | 0.10 | 0.10 | 0.00 |

Enzyme 0.05 per cent. Incubation 5 hours at 40° C.

In the preceding tests it will be remembered that the salts themselves are neutral in all the concentrations used, and that the acidity of the reagent is quite uniformly the same for all the concentrations of a given salt, and that the acidity of the control is the acidity of the enzyme solution itself, as is indicated by the figure for "Water" in the control column. It is apparent that the highest saturation is required for marked inhibition, and there is no evidence of chemical action between the enzyme substance and the toxic salt. The cause of the inhibition may be simply osmotic. In all of the remaining tests it will be noted that the toxic salt solution has more or less acidity of its own (due to hydrolytic dissociation) according to the dilution, and in several cases the control acidity is greater than the sum of the enzyme acidity and of the reagent acidity. It seems, in some cases at least, that there is chemical action between the substance of the enzyme solution and the toxic salt which results in the liberation of acid. In the higher dilutions of the toxic salt the acidity of the salt itself approaches zero, and the acidity of the control tends to be identical with that of the enzyme solution itself. Then again, at the point of total inhibition the reagent acidity and the control acidity are often equal.

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[9] Possibly the enzyme solutions differed sufficiently to account for the discrepancies. Then too, the insolubility of the zymolyte may have been responsible to some extent.

TABLE VIII: *Cadmium and cobalt in contemporaneous test*

CADMIUM

| *m* | Reagent[10] | Control | Enzyme | Increase |
|---|---|---|---|---|
| Water | .... | 0.10 | 0.22 | 0.12 |
| 1024 | 0.02 | 0.20 | 0.33 | 0.13 |
| 512 | 0.04 | 0.30 | 0.40 | 0.10 |
| 256 | 0.06 | 0.40 | 0.50 | 0.10 |
| 128 | 0.10 | 0.55 | 0.60 | 0.05 |
| 64 | 0.20 | 0.60 | 0.63 | 0.03 |
| 32 | 0.30 | 0.90 | 0.90 | 0.00 |

COBALT

| *m* | Reagent[10] | Control | Enzyme | Increase |
|---|---|---|---|---|
| 1024 | 0.03 | 0.20 | 0.33 | 0.13 |
| 512 | 0.06 | 0.33 | 0.43 | 0.10 |
| 256 | 0.08 | 0.43 | 0.52 | 0.09 |
| 128 | 0.10 | 0.70 | 0.77 | 0.07 |
| 64 | 0.15 | 0.90 | 0.92 | 0.02 |
| 32 | 0.30 | 1.00 | 1.00 | 0.00 |

Enzyme 0.05 per cent. Incubation 5 hours at 40 C.

All of the vials contained sediment at the close of incubation. In the unboiled *m*/1024 there was very little precipitate. Before incubation the unboiled solutions remained water clear after the mixture of enzyme and toxic salt until placed in the oven, so that the precipitation was slow.

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[10] This column gives the acidity of 4cc of the toxic salt solution of the concentration indicated by the corresponding figure in the column headed "*m*."

In comparison with the preceding tables there are some points of difference here. The reagent itself is acid and the unboiled preparations show a deposit of substance which tends to be zero in quantity as the dilution of the reagent increases and the acidity consequently decreases. The point of uninhibited activity lies close to that of the lowest concentration of the toxic solution having zero acidity. The acidity of the control is greater than the sum of the reagent acidity and the acidity of the enzyme solution. In this table (VIII) it will be noted that the reagent acidity for $m/32$ cadmium is 0.30, while the corresponding control figure is 0.90. A similar relation holds for cobalt. The same relation was observed for these salts in the work on ethyl butyrate. That cadmium and cobalt are more toxic than sodium, potassium, lithium, barium, strontium, and magnesium is certain. Thus it appears that the first inhibitory effect in our series, which seems more likely to be due to chemical action than to osmotic surface tension or other physical influences, is associated with substances having a natural acidity.

TABLE IX: *Copper and zinc in contemporaneous test*

COPPER

| *m* | Reagent | Control | Enzyme | Increase |
|---|---|---|---|---|
| Water........ | .... | 0.07 | 0.19 | 0.12 |
| 16384........ | 0.00 | 0.10 | 0.19 | 0.09 |
| 8192........ | 0.05 | 0.13 | 0.19 | 0.06 |
| 4096........ | 0.10 | 0.17 | 0.22 | 0.05 |
| 2048........ | 0.20 | 0.23 | 0.27 | 0.04 |
| 1024........ | 0.40 | 0.40 | 0.40 | 0.00 |
| ZINC | | | | |
| 16384........ | 0.00 | 0.10 | 0.19 | 0.09 |
| 8192........ | 0.05 | 0.13 | 0.19 | 0.06 |
| 4096........ | 0.10 | 0.17 | 0.22 | 0.05 |
| 2048........ | 0.20 | 0.25 | 0.30 | 0.05 |
| 1024........ | 0.40 | 0.40 | 0.40 | 0.00 |

Enzyme 0.05 per cent. Incubation 5 hours at 40 C.

In this test copper and zinc are certainly equitoxic. Copper is much more active in the precipitation of substance from the solution. All the unboiled solutions with zinc were free from sediment after incubation, showing that inhibition is not necessarily associated with precipitation. In the copper solutions sediment was present in all concentrations except *m*/16384. The amount of the precipitate varies directly with the concentration of the reagent.

TABLE X: *Copper and lead in contemporaneous test*

| *m* | Reagent | Control | Enzyme | Increase |
|---|---|---|---|---|
| | | COPPER | | |
| Water........ | .... | 0.10 | 0.20 | 0.10 |
| 16384........ | 0.00 | 0.10 | 0.20 | 0.10 |
| 8192........ | 0.05 | 0.15 | 0.20 | 0.05 |
| 4096........ | 0.10 | 0.18 | 0.22 | 0.04 |
| 2048........ | 0.20 | 0.23 | 0.26 | 0.03 |
| 1024........ | 0.40 | 0.40 | 0.40 | 0.00 |
| | | LEAD | | |
| 16384........ | 0.00 | 0.10 | 0.20 | 0.10 |
| 8192........ | 0.00 | 0.10 | 0.20 | 0.10 |
| 4096........ | 0.03 | 0.15 | 0.25 | 0.10 |
| 2048........ | 0.07 | 0.20 | 0.25 | 0.05 |
| 1024........ | 0.16 | 0.35 | 0.40 | 0.05 |

Enzyme 0.05 per cent. Incubation 5 hours at 40 C.

All the vials except the *m*/16384 contained sediment at the close of incubation. The figures for copper are practically a duplicate of those in Table IX. Lead seems to be not quite so toxic as copper in

TABLE XI: *Copper, lead, and zinc in contemporaneous test*

| *m* | Reagent | Control | Enzyme | Increase |
|---|---|---|---|---|
| | | COPPER | | |
| 4096......... | 0.10 | 0.17 | 0.22 | 0.05 |
| 2048......... | 0.20 | 0.23 | 0.26 | 0.03 |
| 1024......... | 0.40 | 0.40 | 0.40 | 0.00 |
| 512......... | 0.70 | 0.70 | 0.70 | 0.00 |
| | | LEAD | | |
| 4096......... | 0.03 | 0.16 | 0.22 | 0.06 |
| 2048......... | 0.07 | 0.24 | 0.28 | 0.04 |
| 1024......... | 0.16 | 0.40 | 0.40 | 0.00 |
| 512......... | 0.35 | 0.50 | 0.50 | 0.00 |
| | | ZINC | | |
| 4096......... | 0.10 | 0.18 | 0.23 | 0.05 |
| 2048......... | 0.20 | 0.26 | 0.30 | 0.04 |
| 1024......... | 0.40 | 0.50 | 0.50 | 0.00 |
| 512......... | 0.85 | 0.85 | 0.85 | 0.00 |

Enzyme 0.05 per cent. Incubation 5 hours at 40° C.

this test. The reagent acidity of lead is correspondingly less than that of copper, although the control figures agree fairly well with those of copper. The point of total inhibition for lead is not determined in this test, so it is not apparent whether the acidity of the reagent and control is identical at that point as was found to be the case with copper and zinc.

In this test lead proves to be equitoxic with copper and zinc. The figures for copper agree closely with those preceding. The figures for zinc agree fairly well, the important difference being that at the point of total inhibition the reagent acidity and control acidity are not identical for the *m*/1024 concentration, although at *m*/512 the coincidence may be noted. The following test is sufficient confirmation of the relation here found.

TABLE XII

| *m* | Control | Enzyme | Increase |
|---|---|---|---|
| COPPER | | | |
| 4096 | 0.13 | 0.20 | 0.07 |
| 2048 | 0.20 | 0.23 | 0.03 |
| 1024 | 0.40 | 0.40 | 0.00 |
| 512 | 0.70 | 0.70 | 0.00 |
| LEAD | | | |
| 4096 | 0.15 | 0.19 | 0.04 |
| 2048 | 0.20 | 0.23 | 0.03 |
| 1024 | 0.30 | 0.30 | 0.00 |
| 512 | 0.50 | 0.50 | 0.00 |
| ZINC | | | |
| 4096 | 0.15 | 0.20 | 0.05 |
| 2048 | 0.23 | 0.27 | 0.04 |
| 1024 | 0.45 | 0.45 | 0.00 |
| 512 | 0.85 | 0.85 | 0.00 |

Enzyme 0.05 per cent. Incubation 5 hours at 40° C.

All the unboiled zinc solutions were free from sediment. The copper and the lead solutions all contained sediment, though the *m*/4096 of each contained only the smallest traces. While total inhibition may apparently occur in the absence of any precipitation, there is always (with the exception of cadmium and cobalt in Table VIII) some inhibition accompanying precipitation.

TABLE XIII: *Mercury and silver in contemporaneous test*

MERCURY

| *m* | Reagent | Control | Enzyme | Increase |
|---|---|---|---|---|
| Water........ | .... | 0.10 | 0.18 | 0.08 |
| 65536........ | 0.00 | 0.10 | 0.15 | 0.05 |
| 32768........ | 0.00 | 0.10 | 0.15 | 0.05 |
| 16384........ | 0.00 | 0.10 | 0.12 | 0.02 |
| 8192........ | 0.05 | 0.10 | 0.10 | 0.00 |
| 4096........ | 0.10 | 0.13 | 0.13 | 0.00 |
| SILVER | | | | |
| 32768........ | 0.00 | 0.10 | 0.15 | 0.05 |
| 16384........ | 0.00 | 0.10 | 0.13 | 0.03 |
| 8192........ | 0.00 | 0.10 | 0.13 | 0.03 |
| 4096........ | 0.00 | 0.10 | 0.12 | 0.02 |
| 2048........ | 0.00 | 0.10 | 0.10 | 0.00 |

Enzyme 0.05 per cent. Incubation 5 hours at 40 C.

In this test mercury is more toxic than silver, even on the equinormal basis, though the difference here is not nearly so great as was found with ethyl butyrate. Of course the greater concentration of the enzyme used here introduces a factor in addition to that of the different zymolyte. Mercury in comparison with silver is like copper in comparison with zinc in regard to precipitating power. The point of total inhibition is close to that of the first appearance of a precipitate,

TABLE XIV

MERCURY

| *m* | Control | Enzyme | Increase |
|---|---|---|---|
| 131072........ | 0.10 | 0.15 | 0.05 |
| 65536........ | 0.10 | 0.15 | 0.05 |
| 32768........ | 0.10 | 0.13 | 0.03 |
| 16384........ | 0.10 | 0.10 | 0.00 |
| 8192........ | 0.10 | 0.10 | 0.00 |
| 4096........ | 0.13 | 0.13 | 0.00 |
| SILVER | | | |
| 131072........ | 0.10 | 0.13 | 0.03 |
| 65536........ | 0.10 | 0.13 | 0.03 |
| 32768........ | 0.10 | 0.13 | 0.03 |
| 16384........ | 0.10 | 0.12 | 0.02 |
| 8192........ | 0.10 | 0.12 | 0.02 |
| 4096........ | 0.10 | 0.10 | 0.00 |

Enzyme 0.05 per cent. Incubation 5 hours at 40° C.

but with silver total inhibition may occur in the absence of any precipitation. The following test reinforces the result of this one.

In Table XIV the reagent acidity is omitted, as it may easily be seen in Table XIII and most of the values are zero anyhow. The relative toxicity is the same, athough the exact point of total inhibition is different. In the case of silver there was no deposit in any of the unboiled solutions, while with mercury there was deposit in *m*/16384 and in higher concentrations, while greater dilutions were free from deposit. To determine at what point precipitation first appears in the case of silver the following test was made.

TABLE XV: *Silver in solitary test*

SILVER

| *m* | Control | Enzyme | Increase |
|---|---|---|---|
| Water | 0.10 | 0.15 | 0.05 |
| 262144 | 0.10 | 0.15 | 0.05 |
| 131072 | 0.10 | 0.15 | 0.05 |
| 65536 | 0.10 | 0.13 | 0.03 |
| 32768 | 0.10 | 0.13 | 0.03 |
| 16384 | 0.10 | 0.12 | 0.02 |
| 8192 | 0.10 | 0.12 | 0.02 |
| 4096 | 0.10 | 0.10 | 0.00 |
| 2048 | 0.10 | 0.10 | 0.00 |
| 1024 | 0.15 | 0.15 | 0.00 |

Enzyme 0.05 per cent. Incubation 5 hours at 40 C.

The lowest concentration of the reagent to show any natural acidity was the *m*/1024, and greater dilutions were neutral to the indicator used. The only vials of the unboiled series to show a deposit after incubation were the *m*/1024.

A comparison of the results of this work on the acetate with those obtained in the work on ethyl butyrate shows that the same general relation holds for both. The metals fall into groups according to toxicity. The groups are not so clearly separated in the case of the acetate, but still sufficiently distinct to confirm the conclusion drawn in regard to the lipolysis of ethyl butyrate.

In the work on the ethyl butyrate it was found that the relative toxicity changes according to the concentration of the enzyme—a result not in accord with the conclusion of CALDWELL (*l. c.*). The following tests show that concentration of the enzyme is a factor in relative toxicity, and adds emphasis to my result with ethyl butyrate.

## TABLE XVI

### Relative toxicity with varying concentrations of the enzyme

*Copper and zinc in contemporaneous test*

COPPER

| m | Control | Enzyme | Increase |
|---|---|---|---|
| 2048 | 0.27 | 0.32 | 0.05 |
| 1024 | 0.42 | 0.46 | 0.04 |
| 512 | 0.77 | 0.80 | 0.03 |
| 256 | 1.50 | 1.50 | 0.00 |
| 128 | 2.90 | 2.90 | 0.00 |

ZINC

| m | Control | Enzyme | Increase |
|---|---|---|---|
| 2048 | 0.30 | 0.38 | 0.08 |
| 1024 | 0.47 | 0.53 | 0.06 |
| 512 | 0.90 | 0.96 | 0.06 |
| 256 | 1.73 | 1.77 | 0.04 |
| 128 | 3.30 | 3.30 | 0.00 |

Enzyme 0.10 per cent. Incubation 5 hours at 40° C.

In Tables IX, XI, and XII, copper and zinc have the same point of total inhibition, namely *m*/1024. In those tests the concentration of the enzyme was 0.05 per cent. Here when the concentration of the enzyme is doubled the relative toxicity is changed. The point of total inhibition for copper is *m*/256 and for zinc *m*/128. In Table XVII where the concentration of the enzyme is still higher, the difference in toxicity is more pronounced.

## TABLE XVII

COPPER

| m | Control | Enzyme | Increase |
|---|---|---|---|
| 2048 | 0.33 | 0.47 | 0.14 |
| 1024 | 0.50 | 0.55 | 0.05 |
| 512 | 0.80 | 0.85 | 0.05 |
| 256 | ~~1950~~ | 1.50 | 0.00 1.50 |
| 128 | 2.90 | 2.90 | 0.00 |

ZINC

| m | Control | Enzyme | Increase |
|---|---|---|---|
| 2048 | 0.32 | 0.47 | 0.15 |
| 1024 | 0.50 | 0.65 | 0.15 |
| 512 | 0.87 | 1.02 | 0.15 |
| 256 | 1.70 | 1.80 | 0.10 |
| 128 | 3.40 | 3.50 | 0.10 |

Enzyme 0.15 per cent. Incubation 5 hours at 40° C.

In the work on ethyl butyrate, cadmium, cobalt, and zinc were found to become equitoxic with increasing concentration of the enzyme. Here the relative toxicity of zinc as compared with that of copper decreases with increasing concentration of the enzyme. In both cases the tendency of zinc to lose in relative toxicity with increasing concentration of the enzyme is apparent.

TABLE XVIII: *Mercury and silver in contemporaneous test*

MERCURY

| *m* | Control | Enzyme | Increase |
|---|---|---|---|
| 8192 | 0.20 | 0.25 | 0.05 |
| 4096 | 0.25 | 0.25 | 0.00 |
| 2048 | 0.33 | 0.33 | 0.00 |
| 1024 | 0.35 | 0.35 | 0.00 |
| 512 | 0.53 | 0.53 | 0.00 |
| SILVER | | | |
| 8192 | 0.20 | 0.25 | 0.05 |
| 4096 | 0.20 | 0.24 | 0.04 |
| 2048 | 0.20 | 0.23 | 0.03 |
| 1024 | 0.26 | 0.26 | 0.00 |
| 512 | 0.33 | 0.33 | 0.00 |

Enzyme 0.10 per cent. Incubation 5 hours at 40° C.

Here the point of total inhibition for copper is the same as with the lower concentration of the enzyme in the preceding table, but the zinc fails to inhibit totally and shows plainly that it loses toxicity faster than copper as the concentration of the enzyme increases.

TABLE XIX

MERCURY

| *m* | Control | Enzyme | Increase |
|---|---|---|---|
| 8192 | 0.25 | 0.40 | 0.15 |
| 4096 | 0.25 | 0.35 | 0.10 |
| 2048 | 0.35 | 0.40 | 0.05 |
| 1024 | 0.50 | 0.55 | 0.05 |
| 512 | 0.85 | 0.88 | 0.03 |
| SILVER | | | |
| 8192 | 0.25 | 0.35 | 0.10 |
| 4096 | 0.25 | 0.35 | 0.10 |
| 2048 | 0.25 | 0.32 | 0.07 |
| 1024 | 0.28 | 0.33 | 0.05 |
| 512 | 0.35 | 0.40 | 0.05 |

Enzyme 0.15 per cent. Incubation 5 hours at 40° C.

In Tables XIII and XIV mercury is four times more toxic than silver on the equimolecular basis. The same relative toxicity is maintained here as in those tables, although greater concentration of both salts is required for total inhibition.

Here the two salts are practically equitoxic, so that in some cases, with increasing concentration of the enzyme, salts, which are equitoxic become unequal in toxicity, while others that are not equitoxic under certain conditions become so under other conditions. Perhaps the only conclusion that can be safely drawn from this group of tests is that the concentration of the enzyme influences relative toxicity, and that a relation which holds for one concentration of the enzyme may not hold for another four or five times greater.

## RELATIVE TOXICITY OF EQUICATIONIC SOLUTIONS

By calculation[11] it may be determined that copper and lead of *m*/2048 concentration are equicationic, and by examination of my results it is seen that those solutions are about equitoxic. On the other hand, *m*/1971 of barium is equicationic with copper *m*/2048,

TABLE XX: Ethyl butyrate

*Barium, lead, copper, and potassium in contemporaneous test*

| *m* | Control | Enzyme | Increase |
|---|---|---|---|
| BARIUM | | | |
| Water | 0.00 | 0.20 | 0.20 |
| 2048 | 0.00 | 0.20 | 0.20 |
| 1024 | 0.00 | 0.20 | 0.20 |
| POTASSIUM | | | |
| 2048 | 0.00 | 0.20 | 0.20 |
| 1024 | 0.00 | 0.20 | 0.20 |
| LEAD | | | |
| 2048 | 0.10 | 0.30 | 0.20 |
| 1024 | 0.20 | 0.30 | 0.10 |
| COPPER | | | |
| 2048 | 0.15 | 0.30 | 0.15 |
| 1024 | 0.20 | 0.30 | 0.10 |

Enzyme .0125 per cent. Incubation 4 hours at 35° C.

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[11] All of the equicationic calculations were made for me by Dr. Wm. N. Berg of the Laboratory of Biological Chemistry of Columbia University.

but reference to the tables shows that such a concentration of barium is entirely without inhibitory effect upon the concentration of the enzyme tried. So by calculation it is seen that *m*/2030 of potassium is equicationic with copper *m*/2048, but reference to the table shows that potassium of such concentration is not toxic. In order to leave no doubt that cation concentration is not a determining factor in toxicity to the extent that equicationic solutions are equitoxic, the following tests were made.

According to calculation, the following solutions are equicationic: copper and lead *m*/2048, potassium *m*/2030, barium *m*/1971. Instead of making the exact concentrations for barium and potassium, it was assumed that if *m*/1024 and *m*/2048 do not inhibit, intermediate concentrations would not. Examination of the results shows that there is no basis for regarding equicationic solutions as even probably equitoxic. Neither of the concentrations of barium tried nor of potassium are inhibiting, while both of copper and one of lead are. By calculation it is easy to see that there is no fixed relation apparent between equitoxicity and equicationic concentration. The exceptions may be multiplied. Thus in the butyrate tests in my other paper, copper *m*/512 and lead *m*/512 are equicationic, equidissociated, and equitoxic. On the other hand, barium *m*/8 and copper *m*/512 are equitoxic, but the relative number of cations per unit volume of those elements in those concentrations is 38 to 1. That is, in unit volume of barium *m*/8 there are 38 cations as compared with 1 cation in unit volume of copper *m*/512. The test shown in Table XXI with ethyl acetate shows that equicationic solutions may totally inhibit or may not inhibit at all according to the salts compared.

According to the calculation from the conductivity tables, the following nitrates have a cation concentration of *m*/80.7: barium *m*/64, copper *m*/70, lead *m*/64, and potassium *m*/76. Reference to the above test shows that all of those concentrations are included within the limits of the test, and yet copper and lead totally inhibit, while barium and potassium do not inhibit at all.

## DISCUSSION

The attempt to correlate physiological action with certain physical or chemical properties either of the ions or of the atoms has thus far been unsuccessful.[12] In view of the really large attention that has been devoted to this subject, it seems surprising that no generalization has been satisfactorily established (Berg and Gies, *l. c.*). The affinity of ions for their charges is such a fundamental property that we can hardly conceive of a chemical reaction involving solution in which this affinity or solution-tension, as some have called it, does not play a part. On the other hand, there is abundant evidence offered by my experiments to show that there is no fixed relation between toxicity and solution-tension to the extent that the toxicity of substances can be exactly estimated from their solution-tension (Pond, *l. c.* 274). There is difficulty even in agreeing upon a standard of toxicity. The minimum lethal dose measures the fatal toxicity, but is it a standard of toxicity? Does total inhibition measure the toxicity in my own experiments? In Table XIII we see that *m*/16384 and *m*/32768 of both mercury and silver are inhibiting and equally inhibiting, but for

TABLE XXI: Ethyl acetate

*Barium, lead, copper, and potassium in contemporaneous test*

| *m* | Control | Enzyme | Increase |
|---|---|---|---|
| COPPER | | | |
| Water | 0.12 | 0.27 | 0.15 |
| 128 | 2.90 | 2.90 | 0.00 |
| 64 | 5.70 | 5.70 | 0.00 |
| LEAD | | | |
| 128 | 2.10 | 2.10 | 0.00 |
| 64 | 4.20 | 4.20 | 0.00 |
| BARIUM | | | |
| 128 | 0.12 | 0.27 | 0.15 |
| 64 | 0.12 | 0.27 | 0.15 |
| POTASSIUM | | | |
| 128 | 0.12 | 0.27 | 0.15 |
| 64 | 0.12 | 0.27 | 0.15 |

Enzyme 0.10 per cent. Incubation 5 hours at 40° C.

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[12] The following paper offers a recent and thorough digest of the more important literature of this subject: Berg, Wm. N., The relation between the physiological action of ions and their physico-chemical properties. New York Medical Journal for July 20 and July 27, 1907. pp. 42.

total inhibition four times greater equimolecular concentration of silver is required than of mercury. (See also POND, *l. c.* 268.)

A critical examination of my own results and those of others fails to reveal any general relation without exceptions, or any property or factor that can be regarded as exclusively fundamental and as solely determining the relative toxicity of a wide series of salts.

Each of the salts I have tested is a nitrate except one, the chlorid of mercury. The members of the series fall into two groups, the neutral salts which do not hydrolytically dissociate in aqueous solution, and the hydrolytes which do so dissociate and whose solution is therefore acid or alkaline according to whether the H or OH ion is predominant. All of the hydrolytes of my series are acid, but as the dilution increases the acidity decreases to zero as here tested.

This difference between the neutral salts and the hydrolytes shows very clearly in the acidity of the controls. The controls of the neutral salts have practically the same acidity as the enzyme solution itself, that is, there is no evidence of any alteration of the acidity of the boiled enzyme solution as a consequence of the mixture with the neutral salt solution. Thus in Tables I–VII inclusive the acidity of the control is about the same for each concentration of the salt. This acidity is close to if not identical with the acidity of the plain boiled enzyme solution as indicated by the figures corresponding to "Water."

In the other tables, however, where the salts have an acid reaction in consequence of their hydrolytic dissociation, the acidity of the control and of the reagent varies considerably (POND, *l. c.* 283). Thus in Table VIII the acidity of the plain control without salt present is 0.10. The acidity of *m*/1024 cadmium is 0.02, but when the control for *m*/1024 is observed, the figure is 0.20 or considerably more than the sum of reagent and enzyme. In regard to this behavior there is much variation among the hydrolytes. Thus at the point of total inhibition the reagent acidity and control acidity may be identical, as with copper and zinc in Table IX, or considerably different, as in Table VIII with cadmium. It is difficult to interpret this with assurance.

It is notable that the neutral salts are not of equal toxicity either in the saponification of the acetate or of the butyrate (POND, *l. c.* 265, 266). Thus in Table VII barium is more toxic than lithium, so that we cannot correlate the degree of toxicity with the degree of hydrolytic dissociation in any close way, though it is true that all of the hydrolytes in the tests I have made are more toxic than any of the neutral salts.

The fact that the hydrolytes themselves are potent in saponification has long been known, in fact the degree of hydrolysis has been measured by the rate of the saponification of esters.[13] Such salts have also been found to be potent in the inversion of sugars.[14] It was supposed that the inverting or saponifying power is associated with hydrolytic dissociation, the H or the OH ions being the active agents. LEY[15] (p. 214), however, found that KCl can invert sugar, so that other ions than those resulting from hydrolytic dissociation are potent. Thus it seems that exceptions arise to intercept the formulation of any generalization.

Significant also is the fact that dilutions of silver and mercury so great that the reaction is neutral as tested are capable of causing total inhibition. On the other hand, solutions of the neutral salts which are comparatively very concentrated are not inhibiting. Thus in Table XIII, *m*/2048 of silver is totally inhibiting but not measurably acid. In some cases we find that solutions of equal acidity are also equitoxic (Tables VIII and IX especially). This relation, however, fails in some cases (Tables X and XI). Moreover, partial or total inhibition may occur with the hydrolytes at dilutions too great to show acidity as here tested. Thus copper and zinc in Table IX show partial inhibition at *m*/16384, which is neutral, and mercury at *m*/16384 in Table XIII shows almost total inhibition without acidity, while silver in Table XIII shows total inhibition in a neutral concentration of the salt.

The relative toxicity changes as the concentration of the enzyme changes, provided the difference is enough. Thus in Tables IX, XI, and XII copper and zinc are equitoxic, but in Table XVI they are less equal, and in Table XVII still less so with the increasing concentration of the enzyme. Similar variations were found in the tests with ethyl butyrate (POND, *l. c.* 276).

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[13] SHIELDS, JOHN, Ueber Hydrolysis in wässerigen Salzlösungen. Zeitsch. physikalische Chem. **12**:167–187. 1893.

[14] LONG, J. H., On the inversion of sugar by salts. Jour. Amer. Chem. Soc. **18**:120–130. 1896.

[15] LEY, H., Studien über die hydrolytische Dissociation der Salzlösungen. Zeitsch. physikalische Chem. **30**:193–257. 1899.

Just to what extent precipitation during incubation is a factor in inhibition is difficult to say. The results show that precipitation occurs in concentrations which cause total and often only partial inhibition. However, with zinc (Tables IX and XII) and silver (Tables XIV and XV) we find total inhibition without precipitation.

The enzyme itself, that is, the substance exhibiting zymolytic power, is probably a reversible colloid, and since it was not precipitated by the neutral salts used, it may be assumed to have gone into colloidal solution rather than into suspension. Perhaps it also is a hydrolyte liberating both H and OH ions. If this is the case, its saponifying power may be associated with its hydrolytic dissociation, just as has been that of the salt hydrolytes. The toxicity of the salt might even be referred to the possibility that the excess of H or of OH ions resulting from the hydrolysis of the salt prevented the hydrolytic dissociation of the enzyme substance and therefore caused the inhibition[16] (p. 214). If so, to what is the toxicity of the neutral salts to be referred? Also, why are the very highly diluted and therefore neutral solutions of silver and mercury capable of causing total inhibition? May not the chemical nature of the atom be a factor? Since convincing evidence is not available for a negative answer, and since theoretical argument based upon the negative assumption leads to embarrassing conclusions,[17] it is obvious that in any effort to discover final causes this possibility should not be ignored.

The tests with equicationic solutions show the futility of any attempt at generalization in that direction and at every hand exceptions seem to arise.

## CONCLUSION

In the zymolytic saponification of ethyl acetate as in that of ethyl butyrate, the toxicity of the salts tested does not under the conditions specified vary inversely with the decomposition tension of those salts.

The concentration of the enzyme is a factor in relative toxicity in some cases.

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[16] BREDIG, G., Beiträge zur Stoichiometrie der Ionenbeweglichkeit. Zeitsch. physikalische Chem. **13**:191–288. 1894.

[17] BERG, *l. c.* pp. 15–20.

NOTE.—In referring to POND (*l. c.*), note the following errata: p. 274, bottom line, "Zinc and cadmium" should read Zinc and barium; p. 283, line 13 from top, "Table XIII" should read Table XIV.

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# STUDIES OF WEST INDIAN PLANTS—I

BY NATHANIEL LORD BRITTON

NEW YORK

1908

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[From the BULLETIN OF THE TORREY BOTANICAL CLUB 35: 337-345. 1908]

# Studies of West Indian plants — I

NATHANIEL LORD BRITTON

## 1. THE JAMAICAN SPECIES OF HERNANDIA

On March 20, 1908, while exploring a wooded hill near Dolphin Head Mountain, parish of Hanover, in the western part of Jamaica, in company with Mr. William Harris, we observed large trees which were unknown to us from the character of their trunks, and too high to enable us to determine the character of their foliage without a pair of field glasses, which we did not have along that day. While sitting at lunch in a relatively open place in the forest, we observed the top of one of these trees, some 30 meters high and at least a meter in diameter, against the sky line, and saw that it was covered with round fruits, some of which we found on the ground under this tree, and realized that we had found a very interesting species. Our negro guide felled a somewhat smaller tree with his machete, and thus enabled us to obtain excellent fruiting herbarium and museum specimens of the Jamaican species of *Hernandia*.

Up to this time the tree does not appear to have been definitely known to botanists in the island of Jamaica. Patrick Browne (Civil and Natural History of Jamaica, 373, 1756), admits the genus and remarks: "This tree is pretty common in Barbadoes and Mountserat, and grows to a considerable size in those islands; but I have not seen any in Jamaica, though I have been credibly informed that it was frequent in the parish of Portland. The cups that sustain and partly invelop the nuts are very large, and, as they move in the wind, keep a whistling noise, which is often frightful to unwary travellers. The seeds are very oily." Browne cites Jack-in-a-Box as a common name.

In Flora of the British West Indian Islands, page 285, published in 1860, Grisebach does not attribute the tree to Jamaica at all, thus indicating that no specimens of it were extant at that time, but Meissner, in DeCandolle's Prodromus ($15^1$: 263. 1864), does credit it to Jamaica, and cites P. Browne, although, as he omits an exclamation mark, it is evident that he did not see a specimen, nor does his herbarium, now at the New York Botanical Garden, contain any *Hernandia* from Jamaica; Meissner refers the record of P. Browne to the species *Hernandia sonora* L., native of the Windward Islands and Porto Rico, and perhaps also of the East Indies.

*Hernandia sonora* is readily distinguishable from the other species by its peltate, long-pointed leaves, and the only other West Indian species known is the Cuban *Hernandia cubensis* Griseb., which has narrow long-acuminate leaves. Under *H. sonora*, Meissner (DC. Prodr. 264) notes a variety *guadeloupensis* from Guadeloupe Island, which has leaves rounded at the apex and base, or slightly cordate. It is possible but not probable that this is the same as the Jamaican tree, but the description is insufficient to make this certain. In any event, the Jamaican tree is evidently specifically distinct from either *H. sonora*, or *H. cubensis*. There is a species of *Hernandia*, *H. guianensis*, in French Guiana, but not much is known of it other than the plate of Aublet, Pl. Guian. *pl. 329*, which shows that this must be quite different from the plant here to be described.

### **Hernandia jamaicensis** Britton & Harris

A tree 30 m. high or less, with spreading and ascending stout branches, the trunk becoming at least a meter in diameter, the young twigs more or less flattened and angled. Leaves subcoriaceous, sometimes 2.5 dm. long; petioles stout, somewhat shorter than the blade, but sometimes 1 dm. in length, the blades elliptic to elliptic-obovate, obtuse at the apex, obtuse or subcuneate at the base, 3-nerved or faintly 5-nerved, not at all peltate; inflorescence as long as the leaves or longer, racemose or racemose-paniculate; calyx of the pistillate flowers turbinate, about 5 mm. long, its margin truncate; fruiting calyx subglobose, yellow, fleshy, 3–4 cm. long and about as thick as long, its wall about 1 mm. thick, its orifice 1.5–2 cm. wide with a slightly raised margin; drupe ovoid, nearly 2 cm. long, 1.5 cm. in diameter, rounded at the base, bluntly pointed, bluntly 8-ribbed and rugose between the ribs.

On wooded hill, at about 400 meters altitude, near Dolphin Head, Jamaica (*Britton 2321*, type; *Harris 10312*); Woodstock, Westmoreland, Jamaica (*Harris 9835*).

## 2. THE GENUS CASSIPOUREA IN JAMAICA

*Cassipourea* was proposed by Aublet (Hist. Pl. Guian. **1**: 528) in 1775 for a tree of French Guiana, his *Cassipourea guianensis* being the type of the genus. Swartz (Prodr. 84) published the generic name *Legnotis*, including in it two species, *L. elliptica* from Jamaica and *L. Cassipourea*, based on Aublet's *Cassipourea guianensis;* he assigns no reason why his name thus published in 1788 should replace Aublet's *Cassipourea* of 1775. Poiret (Lam. Encycl. Suppl. **2**: 131) properly adopted the older generic name and transferred the *Legnotis elliptica* of Swartz to it. A number of additional species from tropical America and Africa have since been added by several authors, including *Cassipourea alba* Griseb. from the island of Dominica. That *Cassipourea* Aublet and *Legnotis* Swartz are the same genus seems evident from an examination of specimens.

*Cassipourea elliptica* (Sw.) Poir. is a shrub or small tree, sometimes reaching 6 meters in height, and grows in Jamaica on rocky wooded hillsides. Its elliptic long-pointed leaves are as brilliantly shining as those of any plant known to me, and individuals seen in contrast to the duller luster of other trees and shrubs stand out as most striking elements in the landscape. Mr. Harris, Dr. Hollick, and I, while botanizing near Kempshot, at an altitude of about 500 meters in the parish of St. James, western Jamaica, on March 23, 1908, had our first opportunity of studying this wonderfully beautiful plant in the field, and were fortunate enough to see its bright white flowers with strikingly laciniate petals, and it was an experience long to be remembered. The lustrous leaves and pediceled flowers distinguish *Cassipourea elliptica* from the two species to be described below. A remarkable feature of an individual tree found by us near Kempshot on March 24, 1908, is the development of the lower branches, which droop and bear leaves not more than one half the size of those on the flowering branches above, the twigs of these drooping branches being very slender and repeatedly forked. We preserved herbarium specimens of this curious bud-sport; if cuttings from such a branch could be propagated, they would doubtless yield a weeping *Cassipourea*.

The distinguishing characters of the three Jamaica species are indicated by the following key:

Pedicels as long as the calyx or longer; leaves brilliantly shining. 1. *C. elliptica.*
Pedicels much shorter than the calyx, or scarcely at all developed;
  leaves dull or faintly shining.
  Leaves elliptic-lanceolate, narrowed at the base, the petioles about as long as the calyx. 2. *C. subsessilis.*
  Leaves ovate, subcordate at the base, petioles only half as long as the calyx. 3. *C. subcordata.*

### 1. CASSIPOUREA ELLIPTICA (Sw.) Poiret

On rocky wooded hills, Kempshot and vicinity (*Britton 2397* and *2423; Harris 10330, 10340*); collected also in Jamaica by Swartz and by Purdie.

### 2. **Cassipourea subsessilis** sp. nov.

A tree about 6 m. high with slender spreading branches. Leaves elliptic-lanceolate, 6–9 cm. long, 3.5 cm. wide or less, acuminate at the apex, narrowed at the base, entire-margined, dull green on both sides, or faintly shining above, the midvein prominent beneath, the petioles 4–7 mm. long; flowers solitary in the axils, nearly or quite sessile; calyx campanulate, its tube 3 mm. long, its lobes ovate to ovate-lanceolate, about as long as the tube; ovary appressed-pubescent; capsule subfusiform, appressed-pubescent, about 1.3 mm. long, 2.5 mm. in diameter, surmounted by the persistent appressed-pubescent style.

On wooded hill near Dolphin Head, parish of Hanover, Jamaica, at about 400 meters altitude (*Britton 2316; Harris 10307*).

### 3. **Cassipourea subcordata** sp. nov.

A tree 4 m. high, the twigs rather stout, the branches ascending. Leaves ovate, bright green on both sides but not strongly shining, 5–7 cm. long, 3.5 cm. wide or less, short-acuminate at the apex, subcordate at the base, the midvein prominent beneath, the petioles rather stout, 2–3 mm. long; flowers 1 or 2 together in the axils, very nearly sessile; calyx tube obconic, 2.5 mm. long, the lobes ovate, obtusish, about as long as the tube, petals white, fimbriate.

Along a brook, Troy, Jamaica (*Britton 488*, type); collected also by Mr. Harris at the same place (*no. 9466*).

## 3. THE GENUS TEREBINTHUS P. BR. IN THE WEST INDIES

The type species of *Terebinthus* P. Br. is *Pistacia Simaruba* L., commonly known as the West Indian birch. A subsequent name for the genus is *Bursera* Jacq. but, as shown by Dr. J. N. Rose (Contr. U. S. Nat. Herb. **10** : 118), this name is unavailable, because *Terebinthus* has priority. Seven species are known to me from the West Indies, two of them here to be described as new; the Mexican species have been listed by Dr. Rose.

| | |
|---|---|
| Leaflets broad, ovate, elliptic, or obovate. | |
| Leaflets 3–11, ovate, acuminate or acute. | |
| Leaflets thin; bark exfoliating in thin layers. | 1. *T. Simaruba.* |
| Leaflets coriaceous; bark close. | 2. *T. Hollickii.* |
| Leaflets only 1, obovate to elliptic, obtuse. | 3. *T. simplicifolia.* |
| Leaflets narrow, oblong to lanceolate or oblanceolate. | |
| Leaflets obtuse at the base. | 4. *T. glauca.* |
| Leaflets acute at the base. | |
| Inflorescence elongated, sometimes as long as the leaves. | |
| Leaflets 5–11, linear-oblong to linear-lanceolate. | 5. *T. angustata.* |
| Leaflets 3–5, oblong to oblanceolate. | 6. *T. inaguensis.* |
| Inflorescence short, compact, in fruit not longer than the petioles; leaflets 1–3. | 7. *T. Nashii.* |

### 1. Terebinthus Simaruba (L.) W. F. Wight, Contr. U. S. Nat. Herb. 10: 122. 1906.

*Pistacia Simaruba* L. Sp. Pl. 1026. 1753.
*Bursera gummifera* L. Sp. Pl. ed. 2, 471. 1762.
*Bursera gummifera glabra* Griseb. Fl. Br. W. I. 173. 1859.
*Bursera gummifera pubescens* Engler, in DC. Mon. Phan. **4**: 40. 1883.

Florida; Bahamas; Cuba; Jamaica; Haiti; Porto Rico; St. Thomas to Grenada; Mexico to Colombia and Venezuela.

Most of the Jamaica trees have pubescent twigs and leaf-rachises; this hairy race is evidently the typical one, based by Linnaeus on Sloane, *pl. 199*.

### 2. **Terebinthus Hollickii** sp. nov

A tree 6 m. high, with trunk 2.5 dm. in diameter, its bark about 8 mm. thick, reddish-gray outside, red inside, close, not peeling off in papery layers. Young twigs stout, pubescent; leaves 8–12 cm. long, clustered at the ends of the twigs; rachis pubescent with spreading hairs; leaflets 3–7, coriaceous, ovate 3–6 cm. long, 1.5–3 cm. wide, entire-margined, obliquely rounded at the base, short-acuminate at the apex, glabrous or very nearly so when old, very inconspicuously veined above, rather prominently veined beneath; petiolules stout, 3–5 mm. long; fruiting inflorescence 4–7 cm. long, the raceme simple or slightly compound, its axis pubescent; fruits 8–10 mm. long, about 7 mm. thick, bluntly triangular, on stout pedicels 4 or 5 mm. long; seed sharply 3-angled.

Dry rocky hillside, Fort Henderson, Kingston Harbor, Jamaica (*N. L. Britton & Arthur Hollick*, March 2, 1908, *no. 1816*).

### 3. **Terebinthus simplicifolia** (DC.)

*Bursera simplicifolia* DC. Prodr. **2**: 78. 1825.

Frequent on dry hillsides near the southern coast of Jamaica, becoming at least 13 meters high.

### 4. **Terebinthus glauca** (Griseb.)

*Bursera glauca* Griseb. Cat. Pl. Cuba 66. 1866.

Cuba.

### 5. **Terebinthus angustata** (Griseb.)

*Bursera angustata* Griseb. Cat. Pl. Cuba 65. 1866.

Cuba.

### 6. **Terebinthus inaguensis** (Britton)

*Bursera inaguensis* Britton, Bull. N. Y. Bot. Gard. **3**: 443. 1905.

Bahama Islands, from Eleuthera and Great Guana Cay to Inagua.

*Combs 454*, from Calicita, Santa Clara Province, Cuba, resembles this very closely, more closely than it does *T. angustata*.

### 7. **Terebinthus Nashii** sp. nov.

A tree about 3 m. high with nearly smooth terete twigs, glabrous throughout. Leaves 1–3-foliolate, the slender petiole 5–15 mm. long, somewhat glaucous; leaflets linear-oblong, narrowed at the base, obtuse or acutish and mucronulate at the apex, 3–5 cm. long, 1–1.5 cm. wide, pale green, very indistinctly veined on both sides, chartaceous; fruiting inflorescence short, few-fruited, 2 cm. long or less; fruits 6–7 mm. long, nearly as thick as long, borne on short stalks, 2–5 mm. long, the calyx persistent at their bases.

Gonaives to La Hotte Rochée on road to Terre Neuve (*Geo. V. Nash & Norman Taylor*, August 12, 1905, *no. 1559*).

## 4. PASSIFLORA CILIATA Ait.

This species was described in 1789 (Hort. Kew. **1** : 310) from plants cultivated by Mrs. Norman, who introduced it into England from Jamaica in that year. In the Botanical Magazine, plate 288, published January 1st, 1795, Curtis remarks that he saw it during the latter part of the preceding summer with great profusion of flowers in several collections, and the figure given by him at this place was made from a plant in the collection of Mr. Vere.

This beautiful passion-flower seems to have been much misunderstood by subsequent botanists. It appears to be confined naturally to the island of Jamaica, where Mrs. Britton found it in March, 1908, in quantities along roadsides through the hills near Bulstrode, parish of Westmoreland, growing with *P. foetida*.

The plant has been supposed to be a variety of *P. foetida*, and has been so ranked by a number of authors. Grisebach, in Flora of the British West Indies, however, regarded it as specifically distinct, but apparently erred in attributing it to the Bahamas as well as to Jamaica. It has not been found in the Bahamas during any of our extensive explorations of that archipelago. So far as one can see, Grisebach was quite justified in maintaining it as a species distinct from *P. foetida*.

## 5. BIDENS PILOSA L.

This species was founded by Linnaeus (Sp. Pl. 832) in 1753 on the "*Bidens latifolia* hirsutior semine angustiore radiato" of Dillenius Hort. Eltham. 51. *pl. 43. f. 51.* The name has since been used by many authors for a very common and well-known tropical weed and often with the remark that it is not pilose. Dr. Gray surmised that the figure of Dillenius might really have been made from a plant of *B. frondosa*. During repeated trips to the West Indies I have looked closely at a great many individuals of this weedy plant but never could find any pilose ones until this spring; the species is usually almost or quite without trichomes. But at Moneague, Parish of St. Ann's, Jamaica, in April, 1908, I noticed with great interest a roadside ditch full of these plants, some densely pilose all over, some essentially glabrous. I could not see at the time of collecting nor have I been able to see from further study of the dried specimens, any other difference whatever in the two races. Both are rayless, have identical achenes varying from 2 to 4, with awns relatively of the same length, leaves of the same shape and texture and involucral scales alike From the environment and occurrence there was nothing to prevent one coming from the seeds of the other. The plants as here observed are not as stout nor as large-leaved as the figure of Dillenius. The typical race of *Bidens pilosa* L. is then well named, but it is apparently rare.

*Bidens leucantha* (L.) Willd. published by Linnaeus as *Coreopsis leucantha* (Sp. Pl. ed. 2. 1282), also a very common tropical weed, has sometimes been regarded as a variety of *B. pilosa.* It has white rays often 1.5 cm. long, and in life appears very different, but herbarium specimens from which the rays have fallen are often difficult to place. It commonly grows with the glabrous *B. pilosa*, but perhaps more frequently in separate patches and in the West Indies one frequently sees large areas inhabited by the one to the exclusion of the other. At Kempshot, near Montego Bay, Jamaica, they grew together in a small garden and I was able to study them side by side; here *B. leucantha* had the involucral scales spreading at flowering time, while those of the glabrous *B. pilosa* were erect. I am inclined to regard *leucantha* as a distinct species. There is a race with undivided leaves.

## 6. THE GENUS MALACHE B. VOGEL.

*Malache scabra* was proposed by B. Vogel (Trew, Pl. Select. 50. *pl. 90.* 1772) as the name of a mangrove-swamp shrub common nearly throughout the West Indian region, subsequently called by Cavanilles (Diss. **3**: 136. *pl. 46. f. 1.* 1787) *Pavonia spicata*, and by Swartz (Fl. Ind. Occ. **2**: 1215. 1800) *Pavonia racemosa.* Trew cites pre-Linnaean names for the plant, and gives a detailed description and a beautiful illustration of it, especially referring to Sloane, Hist. Jam. 221. *pl. 139. f. 2;* Sloane's description and illustration are unmistakable for the species. Linnaeus does not appear to have had any name for it.

*Pavonia* Cav. has as its type species *P. spinifex* Cav. After studying quantities of this and of *Malache scabra*, both in the field and in the herbarium, I am confident that they should not be included in the same genus, inasmuch as they differ too widely in the floral and fruit-structure and in habit; only the most artificial classification can retain them as congeneric.

*Malache scabra* is a typical shrub of coastal swamps from Florida southward through the Caribbean region to Central America, Colombia, Trinidad, and Brazil, and is recorded as growing as far south as Peru on the western side of South America.

Having seen much of this species along mangrove swamps, nearly or quite always within the tidal influence at high water, I was surprised and interested while exploring the high rocky "Cockpit Country" of Jamaica with Mr. William Harris in September, 1907, to find a similar plant on hills in wet woods in the vicinity of Troy, reaching altitudes of at least 600 meters. Mr. Harris had collected fruiting specimens of it the year before, and had noticed its resemblance to the coastal shrub; Professor Urban has recently described it from these specimens (*Harris 9457*), as *Pavonia racemosa* var. *troyana* (Symb. Ant. **5**: 530. 1908). I obtained additional specimens both in flower and fruit in 1907 (*Britton 515*) and from field studies made then in comparison with *Malache scabra* I am convinced that this "Cockpit Country" plant is specifically distinct, and to be called **Malache troyana**; it has broader involucral bracts, much broader and differently shaped carpels, the anther-bearing part of the stamen-column proportionately shorter, and the fruiting peduncles are shorter and stouter. The plant is tall and slender and sometimes approaches the form of a small tree up to 4 or 5 meters high.

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CONTRIBUTIONS FROM THE NEW YORK BOTANICAL GARDEN—No. 109

# A STUDY OF THE DIGESTIVE POWER OF SARRACENIA PURPUREA

BY WINIFRED J. ROBINSON

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# A STUDY OF THE DIGESTIVE POWER OF SARRACENIA PURPUREA

By Winifred J. Robinson

## Introduction

The family Sarraceniaceae consists of three genera, two of which are each represented by a single species, *Heliamphora*, collected in Guiana by Schomburgk and Im Thurm, and *Darlingtonia*, which grows in the mountains of California, while *Sarracenia* has seven species described for eastern North America (Macfarlane, in Engler, Pflanzenreich (Heft 34) **4**$^{110}$: 24. 1908). Natural hybrids have been observed by Harper (Bull. Torrey Club **30**: 332. 1903; **33**: 236. 1906) and Macfarlane (*l. c.* 21) and numerous artificial hybrids have been produced by horticulturalists. All members of the family are native to sunny bogs where their pitchered leaves appear in rosettes from the center of which the flowers arise.

The leaves of *Sarracenia purpurea* are trumpet-shaped with a ventral wing and a terminal lid or lamina (FIG. 1*a*). The outer surface has short, blunt, upwardly directed hairs, cells with the wavy outline of ordinary epidermal cells, and numerous stomata. The inner surface of the terminal portion, or lamina, the "attractive surface" according to Hooker (Nature **10**: 369. 1874) is covered with stiff, reflexed, whitish hairs, the surface of which is corrugated. These contained, in the specimens examined by the writer, a colorless or pinkish fluid with vacuoles, though Vogt (Sitzungsb. Akad. Wiss. Wien **50**: 281. 1864) stated that he found no solid or liquid contents in them but that they were filled with air, and Wunschmann (E. & P. Nat. Pflanzenfam. **3**$^{2}$: 352. 1891) speaks of them as filled with air. At the entrance to the pitcher cavity the hairs cease and a smooth area succeeds, due to the somewhat papillate form of the epidermal cells, which was termed by Hooker the "conducting zone" (FIG. 1*b*). The walls are strongly cuticularized, especially in the rolling margin between the inner and outer surfaces of the pitcher. Below this is a glabrous area, the "glandular zone" (FIG. 1*c*), and at the base of the pitcher is a region which bears long needle-like hairs, the "detentive surface" (FIG. 1*d*). Each of these areas bears glands except the last. Hooker (*l. c.*) stated that there were no honey-glands in *Sarracenia purpurea*, but Schimper (Bot. Zeit. **40**: 227. 1882) thought from the structure of crystals in the upper part of the leaves which he had dried, as well as from the behavior of insects, that nectar glands occurred in the upper part of the pitcher. Goebel (Pflanzenbiol. Schild. **2**: 90. 1891) also described nectar glands in this area. The discrepancy between these two statements may be explained by the theory which Hooker (*l. c.*) has advanced for other species, that "the saccharine fluid only makes its appearance during one particular period in the life of the pitcher." Macfarlane (Ann. Bot. **7**: 407. 1893) says that the protective winter bud-leaves show many honey-glands particularly on the outer surface.

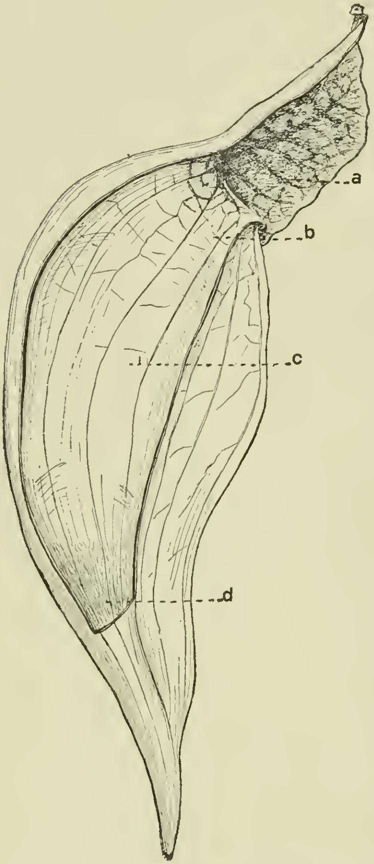

FIG. 1. Leaf of *Sarracenia purpurea* with a portion of the pitcher cut away to show the areas described by Hooker as (*a*) the "attractive surface," (*b*) "conducting zone," (*c*) "glandular -zone," and (*d*) "detentive surface."

St. Hilaire (Morphol. Vég. 142. 1840) and Duchartre (Élém. Bot. 308. 1867) regarded the leaf as a pitchered petiole with a lid which represents the true leaf. Baillon (Compt. Rend. **71**: 639. 1870) compared it to a peltate Nelumbian leaf and interpreted the lower part as the petiole, the pitcher with its wing as corresponding to a ridge on the outer base of peltate leaves of certain Nymphaeaceae, while the lid represents a terminal lobe. Asa Gray described the pitcher as a phyllodium, the terminal lid as the blade of the leaf. Macfarlane (Ann. Bot. **3**: 264. 1889) describes it as the hollowed-out upper part of the midrib "in front of which two elongated green leaflets have fused, producing a prominent wing, a dorsal continuation of the pitchered midrib in flattened form which gives off on either side two leaflets, the whole constituting the lid." He bases this theory largely upon the arrangement of the vascular bundles, which are in two parallel rows with their xylem portions facing each other. Goebel (*l. c.* **2**: 76. 1891) criticizes this view, saying that the primordium of the leaf resembles that of bud-scales with no differentiation into petiole and blade. He regards the lid and pitcher both as parts of the structure termed lamina in the ordinary type of leaf. Bower (Ann. Bot. **4**: 167. 1889) has reviewed the theories of Macfarlane and Goebel and concluded that "the leaf of *Sarracenia* is a simple phyllopodium, consisting of (1) a basal sheathing portion, (2) a middle portion which may be hollowed by involution of the upper surface, and bear upon its upper surface a phyllodineous flap, and (3) the lid which is the simple, flattened termination of the leaf."

The leaves of seedlings, with the exception of the cotyledons, develop as pitchers in all the species that have been examined. Shreve (Bot. Gaz. **42**: 118. 1906) describes the development of seedling leaves of *S. purpurea* as follows: "The first epicotyledonary leaf arises opposite the interval between the cotyledons. It is finger-shaped with a somewhat broadened base. On reaching a length about twice its diameter there begins a rapid lateral outgrowth of the tissue of an O-shaped area on the side of the leaf rudiment which faces the growing point, giving rise to a pit which is destined to become the cavity of the pitchered leaf.

The basal part of the O-shaped outgrowth now begins to grow upward, in which it is accompanied at the same rate by the upper portion of the O, which at the same time carries forward the apical growth of the leaf. The cavity of the pitcher thus grows in depth by the upward growth of the tissue by which it is surrounded. The bottom of the cavity is subsequently elevated by the further growth of the tissue beneath it."

Plants of *S. purpurea* kept under glass for a year at the New York Botanical Garden showed a marked tendency to form blade-like structures instead of ascidial leaves. Goebel (*l. c.* 73) describes in several species this tendency to produce leaves without pitchers at the close of the vegetative period.

The peculiar form of the leaves of *Sarracenia* has attracted the attention of the curious ever since their discovery. A specimen of *S. flava* brought to France by a sailor with the legend that it grew on a fragrant Canadian tree was named leaf of the incense tree (*Thuris Limpidi folium*) and figured by de L'Obel (Adversaria 430. 1570). *S. purpurea* was figured and described by Clusius (Hist. Rar. Pl. 4 : 82. 1601) as a plant whose leaves were like the flowers of Aristolochia. He named it *Limonium peregrinum* from its fancied resemblance to sea-lavender (*Limonium carolinianum*). John Josselyn in "New England's Rarities," 1672, describes it as follows: [John Josselyn, New Eng. Rar. (ed. Tuckerman)—(95). 1865] *Hollow Leaved Lavender* is a Plant that grows in salt Marshes overgrown with Moss, with one straight stalk about the bigness of an Oat straw, better than a Cubit high, upon the top standeth one fantastical Flower, the Leaves grow close from the roots, in shape like a Tankard, hollow, tough, and always full of Water; the root is made up of many strings, growing only in the Moss, and not in the Earth, the whole Plant comes to perfection in *August* when it has Leaves, Stalks, and Flowers as red as blood, except the Flower which hath some yellow admixt."

The Indians of southern Minnesota called it ko-ko-moccasin, or owl's moccasin. From the rhizome and young leaves a concoction was made by the Canadian Indians which they believed to be a remedy for small-pox (Millspaugh, Am. Med. Pl. 19–3. 1887). This has been used to a certain extent in homeopathic pharmacy.

Linnaeus (Sp. Pl. 2d. ed. 728. 1763) adopted the name *Sarracenia* given by Tournefort (Inst. **1** : 657. 1700) in honor of Dr. Sarracin, a physician of Quebec, who sent to France the specimen described by him.

The use of the pitchers to the plant has been variously explained. Catesby (Nat. Hist. Car. **2** : 70. 1754) described them as asylums providentially provided for insects, so that they might escape from the frogs which pursue them, but most writers have thought that the advantage was on the side of the plant rather than that of the insect. Linnaeus (Sys. Veg. 491. 1784) described the evolution of the pitchered leaf and its value to the plant thus: "Sic metamorphosis folii Nymphaeae in folium Sarraceniae, ut ipsa aquam pluvialem excipiens et retinens extra aquas crescat; mira naturaę providentia!"

Wheeler (Bull. Am. Mus. Nat. Hist. **22** : 415. 1906) records the use of pitchers of *Sarracenia* as nesting places for two species of ants (*Dolichoderus Mariae* and *Tapinoma sessile*), which had not apparently suffered from their surroundings. In the same article he speaks of finding nests of a bog-loving species (*Cremogaster lineolata pilosa*) in old pitchers, the proximity of which to the functional, water-containing pitchers had caused many of the workers to drown in their ascidia. Certain carrion flies are reported to lay their eggs in the debris in the bottom of the pitchers, and the larva of one kind of mosquito is said to develop in them, living in them through the winter.

The color of the old pitchers is usually a dark purplish red, but the young pitchers are light green with a network of red veins if they grow in the open, while shade makes them develop a uniform deep green. This is illustrated in the swamps along the railroad near Lakewood, N. J., where the red of the pitchers in the clearing contrasts with the green of those growing under the cedars (*Juniperus virginiana*). Gies (Jour. N. Y. Bot. Garden **4** : 37. 1903) states that the dilute neutral extract of the leaves of *S. purpurea* is practically colorless, an acid extract is crimson, and an alkaline solution, green. He has given the name alkaverdin to the pigment because of the beautiful green color produced by the addition of an alkali. It has a superficial resemblance to the coloring matter of the elderberry and red cabbage, but is unlike them in fundamental chemical characters. The aqueous extract is dextrorotary, reducing, and fermentable. Husemann (Pflanzenstoffe 107. 1871) describes an alkaloid called sarracin in the form of needle-like crystals which can be isolated from the rootstock.

Schimper, in 1882 (Bot. Zeit. **40**: 226. 1882) made digestion experiments upon plants of *S. purpurea* which were growing wild in the Massachusetts bogs. Some of his observations were made upon insects caught by the plants, and some upon pieces of meat that had been placed upon the leaves. He found that on closing the pitcher with tissue paper at the time of opening and thus preventing the free entrance of bacteria the digestion took place no more quickly than in water outside the plant.

Goebel's (*l. c.* 167) experiments were conducted upon plants under cultivation. The pitchers were filled to within 10 cm. of the top, and closed with a cork covered with paraffin. The height of the fluid was measured by a strip of paper fastened on the outside of the pitcher. After 48 hours the following observations were made: The fluid in the pitcher containing 1.0 per cent. formic acid in which fibrin previously swollen had been placed, was lowered 6.8 cm.; the remaining liquid was acid, the fibrin was not attacked. Water in another pitcher was reduced from 10 cm. to 8 cm. by absorption. Meat-extract neutralized with sodium hydroxide was reduced from 10 cm. to 7.5 cm. The meat-extract was full of bacteria, turbid, and alkaline in reaction. A piece of meat the size of a pea was placed with water to a height of 10 cm. in a young green pitcher. After 2 days the column was reduced to 8.2 cm., but the meat had scarcely changed though it was covered with bacteria. A small piece of meat was placed in another young pitcher with meat-extract. After 3 days the meat had a bad odor, but not as unpleasant as that of the control, and it eliminated ammonia.

From the results of these experiments Goebel concluded that *Sarracenia* had no protein dissolving enzyme or antiseptic substance and that the inner surface of the pitcher, especially the lower part, could absorb water and dissolved substances.

## EXPERIMENTS

The present series of experiments was undertaken under the direction of Professor William J. Gies, at the New York Botanical Garden, in the summer and autumn of 1907, in order to determine especially the digestive power of *Sarracenia purpurea* on carbohydrates, fats, and proteins.

The plants were obtained from the sphagnum bogs near Lakewood, N. J., and from a similar locality near Poughkeepsie, N. Y. No difference was observed in the behavior of the plants from the two localities. They were planted in sphagnum and kept in the propagating houses of the New York Botanical Garden under as nearly natural conditions of temperature and moisture as possible. Before a solution was placed in a pitcher the contents were withdrawn by means of a pipette, the pitcher was thoroughly, though gently rinsed with tap-water and distilled water, and swabbed with absorbent cotton. After the solution had been placed in the pitcher, it was covered with lace net which proved effectual in preventing the entrance of insects except during the use of olive oil, which was so attractive to ants that it was necessary to set the crocks containing the plants used for those experiments in dishes containing water to keep the ants out. The materials used in the protein tests were prepared under Professor Gies's personal supervision and great care was taken in handling the others.

Tests were made of the effects of various solutions with the special purpose of providing helpful information for use in the subsequent digestive work.

### I. EFFECTS OF VARIOUS SOLUTIONS

*Acetic Acid.*—A 0.5 per cent. solution of acetic acid was found to be injurious. Pitchers containing it began to wither above the level of the liquid within a few hours, and were dead at the end of six days.

*Potassium Nitrate.*—A dilute solution of potassium nitrate ($m/1024$) proved harmless, though by frequent renewals it was kept in the pitchers a period of six weeks. A 0.5 per cent. solution of potassium nitrate was not injurious. In one case perceptible growth occurred in its presence, but a 1 per cent. solution caused pitchers to wither in six days, while a 2 per cent. solution made them brown and dry in three days. Both young and matured pitchers were used for this experiment but the results were the same in either case.

*Sachs's Nutrient Solution.* — A nutrient solution such as that commonly used as a water culture for flowering plants (per 6,000 c.c.: $CaNO_3$, 6.0 gr.; $KNO_3$, 1.5 gr.; $K_2HPO_4$, 1.5 gr.; $MgSO_4$, 1.5 gr.; $FeSO_4$, a trace) was placed in pitchers, and caused them to begin to decay within a few days, the tissues being entirely dead in from two to three weeks.

*Liebig's Meat Extract.* — The effect of a stimulant was tested by means of a dilute solution of Liebig's meat extract. Bacteria and infusoria developed in great numbers, however, and the pitcher began to wither in less than a week, becoming entirely decayed in about two weeks.

*Milk.* — A solution of milk, one drop in 10 c.c. of distilled water, which was neutral to litmus when placed in the pitcher, gave no odor and no acid reaction with litmus at the end of six days. When the concentration was doubled the solution became acid and the pitcher decayed almost completely in two weeks. A solution of milk, 20 per cent. by volume in distilled water, coagulated and became unpleasant in odor, within two days. It was inferred that the pitcher gave out an alkaline substance which reacted with the acid produced in the very dilute solution of milk but was not sufficient to neutralize the solutions of greater strength. There was nothing to indicate that the milk fat or protein was digested.

*Distilled Water.* — For comparison with the preceding solutions, distilled water was kept in certain pitchers for a period of about five weeks, by means of frequent renewals. There was no change in the external appearance of the pitchers, which is interesting from the fact that a concentrated solution of sucrose was equally harmless, so that the tissue of the pitcher is able to adapt itself to solutions widely different in osmotic strength.

The following solutions were also placed in the pitchers of *Nepenthes distillatoria*, the plants being kept in the propagating houses of the New York Botanical Garden under the same conditions as those of the plants of *Sarracenia.*

*Potassium Nitrate.*— A dilute solution of potassium nitrate ($m/1024$) proved harmless at the end of nine days as far as could be determined from external appearances, but after twelve days the pitcher began to wither.

*Sachs's Nutrient Solution.* — *Nepenthes* pitchers were somewhat more resistant to the nutrient solution than those of *Sarracenia,* as the withering of tissues was not apparent until about eight days had elapsed from the time the solution was put into the pitchers.

*Liebig's Meat Extract.* — *Nepenthes* pitchers proved more resistant to the dilute solution of Liebig's meat extract than *Sarracenia,* as the pitcher contents did not seem foul and the pitchers did not decay during the two weeks which the solution was allowed to remain in them. This may have been due to the digestion of the bacteria by infusoria, which were present in large numbers. Of course it is possible that bacteria were digested by the proteolytic enzyme, nepenthin.

## II. Effects on Carbohydrates

*Glucose.* — A 10 per cent. solution of glucose was placed in pitchers of *Sarracenia* and allowed to remain from four days to three weeks. With Fehling solution they gave the reddish brown coloration promptly in every case, on heating, which indicates that at least some of the glucose remained, although no tests were made to determine the absence of reducing substances that might have been produced from the glucose. The quantity of the latter was naturally diminished by ordinary fermentation. There were no indications of a detrimental influence exerted by any of the fermentation products. The $\alpha$-naphthol test indicated in each case the presence of much carbohydrate.

*Sucrose.* — Solutions of cane sugar (sucrose, c.p.) of a very low degree of concentration (less than 1 per cent.) were introduced into the pitchers of *Sarracenia.*

There was no apparent bad effect. Further trials with stronger solutions were made until it was found that a solution of 33⅓ per cent. could be resisted for two months, with no apparent injury to the pitcher. The growth of the young pitchers containing such a solution was equal, so far as it could be measured, to that of pitchers containing water. Solutions of the various strengths were tested with hot Fehling solution after they had been in the pitchers from three to seven days. The contents of each pitcher gave a reddish precipitate of copper oxide, indicating the production of invert sugar. A heavy reduction of Fehling solution also occurred spontaneously without heating although water from the pitchers did not behave in this way.

As checks for this experiment, Fehling solution, as well as Fehling solution with an equal quantity of the stock sugar solution was boiled, but neither gave an indication of reduction.

*Starch.* — Starch paste was placed in the pitchers and allowed to remain three or four days, in one case as long as thirteen days, when it was removed and tested in the usual way with Fehling solution. The result indicated that a reducing compound, presumably sugar, had been formed, the exact nature of which was not determined however. When Fehling solution was added to starch paste from the pitchers *without boiling*, no reduction occurred, so that the reducing power of the contents was not so marked as in the case of the cane sugar. Tested with iodine, a few blue granules indicated that not all the starch had been hydrated. Toluol sufficient to form a thin film over the top of the fluid in the pitcher was added in some cases but the reduction was the same as in the case of pitchers to which no antiseptic had been added. From this it may be concluded that the change from starch to reducing substance (sugar ?) is due to an enzyme secreted by the cells of the pitcher. There were no indications of fermentation in the pitchers with toluolized contents.

As checks in the experiments on the action of the pitchers upon starch paste, Fehling solution was tested by boiling; tap-water and Fehling solution were boiled together; and tap-water which had been in the pitchers for the same length of time and under the same conditions as the starch paste, was boiled with Fehling solution; also, tap-water to which toluol had been added, and which had been allowed to stand in the pitchers the same length of time. Samples of the fresh starch paste and of that which had been allowed to stand in a flask near the pitchers, with and without the addition of toluol, were boiled with Fehling solution. In no case was there any reduction, hence the reduction which occurred with the liquid from the pitchers cannot be attributed to impurities in the fluids used in the experiments.

The above carbohydrates were also introduced into the pitchers of *Nepenthes*, with the following results :

A solution of glucose of the same concentration as that used in the pitchers of *Sarracenia* was placed in the pitchers of *Nepenthes* and allowed to remain four days with apparently no harmful effects. The test with Fehling solution resulted positively.

A 10 per cent. solution of cane sugar which had been allowed to stand in the pitchers of *Nepenthes* four days was tested with Fehling solution but failed to manifest reducing power, hence it was inferred that no cane sugar reducing enzyme was present in the contents of the pitchers in this experiment. Probably no such enzyme is normally produced by *Nepenthes*.

Thin starch paste was placed in the pitchers of *Nepenthes* and tested after four days with Fehling solution, but no reduction occurred, which indicates that *Nepenthes* does not give out such a starch splitting enzyme as that secreted by *Sarracenia*. The iodine test showed that the starch granules in the paste had not been broken down.

As these experiments were conducted at the same time as those upon *Sarracenia*, the same checks applied to both, making the results all the more significant.

## III. Effects on Fats

*Olive Oil.*—As a test of the fat-digesting power of *Sarracenia*, washed neutral olive oil, in the proportion of 0.4 c.c. of oil to 9.6 c.c. of distilled water or tap-water was used. The mixture was well shaken immediately before it was introduced into the pitchers. After the mixture had been in the pitcher from four to seven days it was removed and titration was effected by means of phenolphthalein as the indicator, the number of drops of *m*/100 potassium hydroxid solution needed to neutralize a uniform quantity of the fluid being taken as a measure of the lipolytic power of the liquid. The amount of alkali required (except in certain abnormal cases, which were caused by the accidental presence of ants in large numbers and consequent putrefactive lipolysis) was the same as for an identical volume of the liquid which had not been introduced into the pitchers, so it may be inferred that no digestion of the fat occurred.

As a check, a mixture of olive oil and water of the same proportion as that used in the preceding experiments, with the addition of toluol was placed in several pitchers but the amount of alkali necessary to neutralize was so nearly the same in every instance as to indicate that the oil was neutral and that no digestion occurred.

*Ethyl Butyrate.* — As a further test of the fat digesting power of *Sarracenia*, tap-water which had been left in the pitchers one day was removed and placed in stoppered bottles with ethyl butyrate in the proportion of four drops of the butyrate to 2 c.c. of the pitcher liquid. It was allowed to remain at room temperature twenty-four hours and then titrated, phenolphthalein being used as the indicator and the lipolytic activity of the fluid being measured by the number of drops of $m/100$ sodium hydroxide solution needed to neutralize it. In place of tap-water, a very dilute solution of potassium hydroxide (KOH $m/100$), and also a very dilute solution of acetic acid (KOH $m/100$), was used in testing the contents of certain pitchers, but the number of drops of the alkaline solution needed for neutralization did not indicate any digestion.

As a check the stock liquid which had not been in the pitcher was subjected to the same test as the pitcher contents in each case, and the results were practically the same as with the pitcher fluid.

Olive oil and water, in the same proportions as those used in the case of *Sarracenia*, were placed in the pitchers of *Nepenthes* and the titration process was conducted in the same manner, but no digestion was detected.

The experiment with ethyl butyrate was repeated with the substitution of tap-water which had been in the pitchers of *Nepenthes* instead of *Sarracenia*, one day. No digestion was indicated.

## IV. EFFECTS ON PROTEIN

*Fibrin.* — Water which had been left in the pitchers of *Sarracenia* six days was removed and placed in bottles to each of which a granule of fibrin was added. As checks, toluol was added to some of these, dilute acid to others, and dilute alkali to a third set, the acidity or alkalinity being in each case below the harmful point as determined by the earlier experiments. Toluol was added to a portion of the acid and alkaline mixtures. The result was quite uniform, for the fibrin granule remained apparently unchanged in each liquid.

## GENERAL CONCLUSIONS

The results of the above experiments may be summarized as follows :

1. The pitchers of *Sarracenia purpurea* can adapt themselves to solutions of very different osmotic strengths.
2. They give out an enzyme which hydrates sucrose and starch to reducing materials, presumably simple sugars.
3. They have no fat-digesting power.
4. They do not secrete a protein-dissolving enzyme.

In the tests which were made upon the pitchers of *Nepenthes* the resistance to solutions of marked difference in osmotic strength was shown to be the same as in the case of *Sarracenia.* The plants differed in that *Nepenthes* did not give out into the pitcher cavity any enzyme capable of hydrating sugar and starch, whereas *Sarracenia* did. The experiments as to protein digestion in *Nepenthes* were inconclusive, but they were not repeated partly because of insufficient material and partly because the demonstration of the existence of a protein-dissolving enzyme in *Nepenthes* by Vines (Ann. Bot. **12** : 545. 1898) was accepted as final.

*Sarracenia purpurea* belongs to the class of plants which, like the bromeliads of the tropics or our northern catch-fly, illustrates a mal-adaptation between plants and animals, for while they serve as traps for insects they are neither harmed nor benefited by them, unless the number be very great. In the sphagnum bogs where *Sarracenia* grows, the concentration of salts and nitrogenous matter about its roots is so great as to place them practically under xerophytic conditions. This would tend to render the root system inefficient as a means of water absorption and make the possession of a water-storing organ like the pitchered leaf of great advantage to the plant.

The epiphyte *Nepenthes* represents the highest degree of adaptation, in that it produces a protein-dissolving enzyme, the nepenthin of Vines (Ann. Bot. **15**: 563. 1901). Even here, however, the absorption of protein by the leaves is not absolutely essential to the life of the plant, though of great advantage. *Nepenthes*, then, stands at the upper limit in the evolution of plants with pitchered leaves, while *Sarracenia purpurea* is near the lower limit. Between them are numerous forms with varying degrees of adaptation.

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# ADDITIONAL PHILIPPINE POLYPORACEAE

By WILLIAM ALPHONSO MURRILL

NEW YORK
1908

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[From the BULLETIN OF THE TORREY BOTANICAL CLUB 35: 391-416. 1908]

# Additional Philippine Polyporaceae

WILLIAM ALPHONSO MURRILL

A list of Philippine polypores recently added to the herbarium of the New York Botanical Garden was published in this journal about a year ago (Bull. Torrey Club **34**: 465–481. 1907). In April, 1908, a large and valuable shipment of Philippine fungi, 637 packets in all, was received for determination from the Bureau of Science, Manila, through Mr. Elmer D. Merrill, botanist. Most of these are duplicates and will become permanent additions to the Garden herbarium, but a few, not in duplicate, will be returned to Manila. The following list includes the pileate polypores of this collection, arranged in alphabetical order under their tribes.

The localities here included are very varied, representing a large number of the islands and many different altitudes and latitudes. The principal collectors are as follows: Messrs. Elmer D. Merrill, A. D. E. Elmer, E. B. Copeland, H. M. Curran, M. L. Merritt, H. N. Whitford, Eugenio Fénix, Maximo Ramos, L. Mangubat, and Mrs. Mary S. Clemens. Private numbers or letters follow the name of the collector, those given in parenthesis being assigned by the Bureau of Science or the Bureau of Forestry. Synonyms listed in my former paper are not repeated here except in connection with discussions relative to additional knowledge or notes of interest.

## Tribe POLYPOREAE

BJERKANDERA ADUSTA (Willd.) Karst. Medd. Soc. Faun. Fl. Fenn. **5**: 38. 1879.

Mindanao: Mt. Apo, 2000 m., Davao, *Copeland 1075*; Camp Keithley, Lake Lanao, *Clemens bj*.

**Coltricia benguetensis** Murrill, sp. nov.

Sporophore consisting of several pilei arising on short stipes from a thickened base attached to the host at two points, the pilei being in all stages of development; pileus flabelliform to reniform, usually umbonate behind at the point of attachment, slightly convex above and below, corky, rigid, 3–4 × 4–5 × 0.5–0.8 cm.; surface anoderm, subglabrous, uneven, neither sulcate nor zonate, fulvous behind, ferruginous in front; margin broadly sterile, rather thick, rounded, ferruginous, context ferruginous, corky, zonate, homogeneous, 5 mm. thick; tubes 1–2 mm. long, pallid within, mouths cinereous-fuscous, glistening, regular, angular, 5 to a mm., edges thin, subentire: hyphae ferruginous, 2–3 μ; cystidia scanty, pointed, straight, curved or sinuous, bulbous at the base, dark fulvous, 25–40 μ long, 7–10 μ thick at the thickest part.

Type collected about prostrate logs of *Pinus insularis* at Baguio, Benguet Province, Luzon, October–November, 1905, by E. D. Merrill, (*5003*). Also collected on the same host in Benguet Province, March, 1904, by A. D. E. Elmer, *6047*.

CORIOLOPSIS BADIA (Berk.) Murrill, Bull. Torrey Club **34**: 466. 1907. *P. asper* Jungh., *P. strigatus* Berk., and *P. squamaeformis* Berk. hardly differ specifically from this species. Specimens have also been called *P. brunneopictus* Berk., described from Brazil. In the two collections made by Mrs. Clemens in Mindanao, the pores are much larger than usual, being at least twice their normal size.

Luzon: Montalban, Rizal Province, *Merrill*, (*5085*); Mt. Mariveles, Bataan Province, *Copeland 158*; Bauang, Union Province, *Elmer 5710*; Mt. Arayat, Pampanga Province, *Merrill*, (*5031*); Santa Maria Mavitac, Laguna Province, *Curran*, (*8930*). Mindanao: Camp Keithley, Lake Lanao, *Clemens av, ay*.

CORIOLOPSIS CAPERATA (Berk.) Murrill, N. Am. Flora **9**: 77. 1908. *Polyporus caperatus* Berk. Ann. & Mag. Nat. Hist. **3**: 391. 1839. (Type from the Philippines.)

Mindanao: Mt. Apo, 1300 m., Davao, *Copeland 1178*.

**Coriolopsis Copelandi** Murrill, sp. nov.

Pileus subimbricate, dimidiate, sessile, laterally confluent, broadly attached, very slightly flexible, conchate, 3–4 × 5–6 × 0.3–0.5 cm.; surface glabrous,. thinly encrusted, very shallowly sulcate, slightly radiate-rugose when dry, opaque, very dark brown or black; margin rather thick, sterile, entire: context punky, dark fulvous, 1–2 mm. thick; tubes 3–4 mm. long, dark brown within, hymenium sordid brown, almost blackish in some specimens, cracking when dry, mouths minute, thin-walled, angular, 7–9 to a mm., edges entire to slightly fimbriate.

Type collected on dead wood in Davao, Mindanao, March 28, 1904, by E. B. Copeland *714*. Also collected at Todaya, Davao, Mindanao, April 25, 1904, by E. B. Copeland, (*1214*), and on a dicotyledonous log on the Lamao River, Luzon, February 2, 1904, by E. B. Copeland, *147*.

**Coriolopsis bataanensis** Murrill, sp. nov.

Pileus thin, soft, slightly flexible, rather fragile, dimidiate to flabelliform, often laterally extended by confluence, narrowly attached, conchate, 3–4 × 3–10 × 0.3–0.5 cm.; surface spongy-tomentose, anoderm, very uneven, sulcate, subzonate, fulvous, varying to isabelline or fuliginous in places; margin rather thin, undulate, isabelline: context 2–4 mm. thick, two-layered, soft and dull fulvous above, considerably harder and ochraceous next to the tubes, which are 1–2 mm. long, bay within, mouths glistening, isabelline to bay, distinctly angular, 3–4 to a mm., quite variable in size, edges thin, entire: spores smooth, ovoid, hyaline, rather abundant, 5 × 4 $\mu$; hyphae subhyaline, extremely fragile; cystidia none.

Type collected on dead wood on Mt. Mariveles, 230 m., Bataan Province, Luzon, January 29, 1904, by E. B. Copeland, *143*.

CORIOLOPSIS DERMATODES (Lév.) Murrill, Bull. Torrey Club **34**: 466. 1907. *Polyporus xeranticus* Berk., described from India, is hardly different from this species.

Mindanao: Camp Keithley, Lake Lanao, *Clemens*, two collections. Luzon: Sablan, Benguet Province, *Elmer 6183*; Bauang, Union Province, *Elmer 5747*; Bosoboso, Rizal Province, *Ramos*, (*2158*).

**Coriolopsis melleoflava** Murrill, sp. nov.

Pileus thin, coriaceous, very flexible, broadly effused, narrowly attached, dimidiate to subcircular, 2–3 cm. long, 1 mm. thick, extending several centimeters laterally by confluence; surface clothed with dense short tomentum, many times narrowly concentrically sulcate, melleoflavous, slightly brownish behind; margin undulate or irregularly notched or lobed, thin, sterile, pallid: context melleoflavous, membranous; tubes less than a mm. long, nearly white within, mouths pale melleous, irregular, averaging 2 to a mm., edges notched and more or less elongated, somewhat irpiciform.

Type collected on dead wood at Zamboanga, Mindanao, January, 1908, by H. N. Whitford and W. I. Hutchinson, (*9238*).

CORIOLOPSIS OCCIDENTALIS (Kl.) Murrill, Bull. Torrey Club **32**: 358. 1905.

Mindanao: Camp Keithley, Lake Lanao, *Clemens ap, m*; Pollok Harbor, *Copeland 331*. Negros: Gimagaan River, *Copeland 4*. Mindoro: Bongabong River, *Whitford 1440, 1441*. Batanes: *Fénix*, (*3868*), (*3871*), (*3885*), (*3888*). Luzon: Twin Peaks, Benguet Province, *Elmer 6356*; Lamao Forest Reserve, *Curran* (*7397*).

CORIOLOPSIS SEMILACCATA (Berk.) Murrill, Bull. Torrey Club **34**: 466. 1907.

Luzon: Lamao, Bataan Province, *Copeland 172*, *Curran*, (*7521*); Bosoboso, Rizal Province, *Ramos*, (*1217*); Mauban, Tayabas Province, *Curran*, (*9590*). Mindoro: Mt. Halcon, *Merrill*, (*6119*). Mindanao: Camp Keithley, Lake Lanao, *Clemens ac* and one other collection; Davao, *Copeland 552*. Negros: Gimagaan River, *Copeland 14*.

**Coriolopsis subcrocata** Murrill, sp. nov.

Pileus coriaceous, membranous, flaccid, elastic, effused-reflexed: the reflexed portion dimidiate, applanate, 1–2 cm. long and 1 mm. thick, extending laterally several centimeters; surface pale isabelline, nearly glabrous, very slightly zonate; margin thin, concolorous, entire, sterile: context pale isabelline, soft, very thin; tubes less than 1 mm. long, paler than the context, mouths regular, subcircular, glistening, 3 to a mm., edges firm, corky, entire.

Type collected on a dead trunk and branches on Mt. Mariveles, Bataan Province, Luzon, January 1, 1904, by E. D. Merrill, (*3694*).

CORIOLUS ATYPUS (Lév.) Pat. Tax. Hymén. 94. 1900.

Palawan: Victoria Peak, *Curran*, (*7484*). Mindoro: Mt. Halcon, *Merrill*, (*6121*), (*6122*). Luzon: Rizal Province, *Ramos*, (*1859*), (*1864*); Lamao River, Bataan Province, *Copeland 171*, *179*; Mt. Mariveles, Bataan Province, *Copeland 169*; Zambales Province, *Curran*, (*7020*); Mauban, Tayabas Province, *Curran*, (*9587*). Mindanao: Zamboanga, *Whitford & Hutchinson*, (*9302*); Malita, Davao, *Copeland 683*.

**Coriolus Clemensiae** Murrill, sp. nov.

Pileus rather thin, rigid, reniform, conchate, attached by a compressed projecting base resembling a stipe, 6 × 8 × 0.3 cm., base 2 × 2 × 0.3 cm.; surface glabrous, zonate, radiately furrowed white with a slightly grayish tinge, the narrow zones shining; margin rather thick, fertile, reddish brown in dried specimens, subentire: context milk-white, fibrous, 1–2 mm. thick; tubes pale ochraceous when dry, 2 mm. long, mouths concolorous, 4–5 to a mm., circular to angular, edges firm, rather thick, entire: spores subglobose, smooth, hyaline, 3–4 μ; hyphae hyaline, 3–4 μ; cystidia none.

Type collected on dead wood at Camp Keithley, Lake Lanao, Mindanao, September–October, 1907, by Mary S. Clemens, *v*.

**Coriolus Currani** Murrill, sp. nov.

Pileus flabelliform, thin, somewhat flexible, almost plane above, slightly concave below, affixed by a short tubercle resembling the pileus in surface and substance, 3–5 × 4–6 × 0.1–0.3 cm.; surface isabelline to wood-brown, glabrous, shining, multizonate, smooth between the shallow concentric furrows; margin acute, entire or undulate, pallid, sterile in a narrow distinct band: context white to pallid, homogeneous, punky, 1–1.5 mm. thick; tubes white to pale yellowish throughout, 1–2 mm. long, mouths glistening, circular, very regular, 5–6 to a mm., edges firm, entire, obtuse.

Type collected on dead wood on Mt. Maquiling, Laguna Province, Luzon, October 23, 1907, by H. M. Curran and M. L. Merritt, (*8965*). Also collected as follows: Mt. Maquiling, Laguna Province, Luzon, October 23, 1907, by H. M. Curran and M. L. Merritt, (*8964*); Rizal Province, Luzon, January, 1907, by Maximo Ramos, (*1866*); Batangas Province, Luzon, November, 1907, by H. M. Curran and M. L. Merritt.

CORIOLUS ELONGATUS (Berk.) Pat. Tax. Hymén. 94. 1900.

Luzon: Santa Maria Mavitac, Laguna Province, *Curran*, (*8909*).

CORIOLUS MAXIMUS (Mont.) Murrill, Bull. Torrey Club **34**: 467. 1907.

Mindanao: Mungalaron, Davao, *Copeland 712;* Camp Keithley, Lake Lanao, *Clemens a, k, s, aq;* Port Banga, Zamboanga District, *Whitford & Hutchinson*, (*9411*). Luzon: Lamao River, Bataan Province, *Copeland 174;* Mt. Malaraya, Tayabas Province, *Curran & Merritt*, (*8958*); Zambales Province, *Curran* (*7025*). Balabac: *Mangubat*, (*534*). Mindoro: Bongabong River, *Whitford 1438*.

CORIOLUS MURINUS (Lév.) Pat. Tax. Hymén. 94. 1900.

Luzon: Lamao River, Bataan Province, *Copeland 170, 185*, *247*; Mauban, Tayabas Province, *Curran*, (*9591*), (*9592*); Paete-Piapi, Laguna and Tayabas Provinces, *Curran*, (*9640*), (*9644*); Caraga, Surigao Province, *Merrill*, (*5460*). Mindanao: Camp Keithley, Lake Lanao, *Clemens c*; Davao, *Copeland 458, 925*. Negros: Gimagaan River, *Copeland 5*. Lumbacan: *Merrill* (*5281*).

CORIOLUS NIGROMARGINATUS (Schw.) Murrill, Bull. Torrey Club 32: 649. 1906.

Mindoro: Mt. Halcon, *Merrill*, (*6116*). Negros: Gimagaan River, *Copeland 9*. Luzon: Santa Maria Mavitac, Laguna Province, *Curran*, (*8927*); Antipolo, Rizal Province, *Curran*, (*7042*); Montalban, Rizal Province, *Merrill*, (*5081*). Mindanao: Malita, Davao, *Copeland 668*; Davao, *Copeland 876*; Camp Keithley, Lake Lanao, *Clemens N, af, cg, r*.

CORIOLUS PROLIFICANS (Fr.) Murrill, N. Am. Flora 9: 27. 1907.

Luzon: Lamao Forest Reserve, Bataan Province, *Curran*, (*7396*).

**Coriolus perpusillus** Murrill, sp. nov.

Pileus very small, irregular, laterally confluent, dimidiate, broadly attached, 0.5–1 × 1.5 × 0.2–0.3 cm., surface milk-white, azonate, glabrous, not polished; margin concolorous, entire, sterile, rather thick: context milk-white, punky, fibrous, 1 mm. thick; tubes white to slightly yellowish, very thin-walled, 1 mm. or less long, mouths glistening, nearly white, regular, angular, 6 to a mm., edges thin, toothed or fimbriate.

Type collected on dead wood at Camp Keithley, Lake Lanao, Mindanao, July, 1907, by Mary S. Clemens, *bf*.

**Coriolus rubritinctus** Murrill, sp. nov.

Pileus small, slightly flexible, obovate to flabelliform, more or less cuneate behind, plane above and below, laterally confluent at times, 1.5–2 × 1.5–2.5 × 0.1–0.3 cm.; surface faintly zonate, smooth, glabrous, opaque, ochraceous-fulvous with reddish brown blotches; margin abruptly acute, fertile, concolorous, entire, slightly inflexed on drying: context pallid, punky-fibrous, 1 mm. or less thick; tubes pallid, 2 mm. long, mouths glistening, ochraceous to discolored, regular, angular, 4–5 to a mm., edges corky, thin, entire: spores globose, smooth, hyaline, 2.5–3 $\mu$; hyphae hyaline, 3 $\mu$; cystidia none.

Type collected on dead wood on Mt. Halcon, Mindoro, November, 1906, by E. D. Merrill (*6117*).

**Coriolus subvernicipes** Murrill, sp. nov.

Pileus flabelliform or reniform, subimbricate, thickest behind, becoming very thin and flexible at the margin, narrowly attached, somewhat irregular and plicate, 2–4 × 4–7 × 0.1–0.6 cm.; surface lustrous, glabrous, multizonate, reddish brown, isabelline in a few zones, finely radiate-striate; margin very thin, slightly paler, broadly sterile, notched or irregular: context milk-white, tough, 1–5 mm. thick; tubes short, white to pale yellowish, firm, 1 mm. or less long, mouths glistening, nearly circular, regular, 4–5 to a mm., edges rather thin, entire.

Type collected on dead *Cassia* at Bosoboso, Rizal Province, Luzon, February, 1907, by Maximo Ramos, (*2144*). No. (*2145*) is the same species, collected at the same time.

**Cycloporellus barbatus** Murrill, sp. nov.

Pileus reniform, conchate, thin, flexible, imbricated at times, attached by a short umbo, 3–4 × 5–6 × 0.05–0.1 cm.; surface multizonate, shallowly concentrically sulcate, light brown to dark reddish brown, covered with coarse, blackish brown, appressed hairs 2 mm. or more in length; margin thin, pallid, entire, narrowly sterile: context very thin, fibrous, containing blackish, horny layers; tubes less than 1 mm. long, dark fulvous within, the cavities hoary, mouths regular, angular, glistening, dark brown, 6–7 to a mm., edges entire, becoming thin: spores subglobose, smooth, hyaline, 2–3 μ; hyphae melleous to dark fulvous, 3.5–5 μ; cystidia blackish brown, opaque, slender, hyaline at the tip, regular in shape, rather abundant, 15–25 μ long, 4 μ thick at the base, tapering to a point.

Type collected on dead wood in Zambales Province, Luzon, November–December, 1907, by H. M. Curran and M. L. Merritt, (*8208*).

CYCLOPORELLUS CICHORIACEUS (Fr.) Murrill, Bull. Torrey Club 34: 468. 1907. *Favolus transiens* Cesati, described from Borneo, is not distinct from this species.

Batanes: *Fénix*, (*3874*). Mindanao: Mt. Apo, 2000 m., Davao, *Copeland 1067*.

CYCLOPORELLUS MICROCYCLUS (Lév.) Murrill, Bull. Torrey Club 34: 468. 1907. *Polystictus xerampelinus* Kalchb., described from Australia, should be added to the synonyms of this species.

Luzon: Montalban, Rizal Province, *Merrill*, (*5086*); Mt. Malaraya, Tayabas Province, *Curran & Merritt*, (*8960*); Rizal Province, *Ramos*, (*1860*), *Foxworthy*, (*84*); Mt. Mariveles, 333 m., Bataan Province, *Copeland 144*. Mindanao: Camp Keithley, Lake Lanao, *Clemens ae*, *ah*, *ca*, *j*.

EARLIELLA CORRUGATA (Pers.) Murrill, Bull. Torrey Club **34**: 468. 1907.

Luzon: Mount Maquiling, Laguna Province, *Merrill*, (*5153*); Mount Maquiling, Batangas Province, *Curran & Merritt*, (*8940*); Lamao River, Bataan Province, *Copeland 164*. Panay: Capiz, *Copeland 19*. Balabac: *Mangubat*, (*535*). Mindanao: Davao, *Copeland 477*, *518*: Catalonan, Davao, *Copeland 924*; Camp Keithley, Lake Lanao, *Clemens cd*, *ao*; Caraga, Surigao Province, *Merrill*, (*5459*).

**Favolus resinosus** Murrill, sp. nov.

Pileus sessile, dimidiate, applanate, rigid, attached by a broad base, 6 × 10 × 1–2 cm.; surface anoderm, glabrous, opaque, brown to black, more or less resinous, proliferous, becoming incrusted with age; margin abruptly acute, isabelline with a tinge of flesh-color, undulate or coarsely notched: context corky to indurate, brown with a reddish hue, 2–3 mm. thick; tubes 1 cm. long, large, light brown within, mouths ochraceous, subhexagonal, rigid, 1–2 mm. in diameter, radiately elongated near the margin, reaching 4 mm. at times, edges rather thick, entire: spores subglobose to ovoid, smooth, hyaline, 4–6 $\mu$ long; hyphae hyaline, 3–4 $\mu$; cystidia none.

Type collected on dead wood at Bosoboso, Rizal Province, Luzon, July, 1906, by Maximo Ramos, (*1214*).

**Favolus subrigidus** Murrill, sp. nov.

Pileus sessile, dimidiate, thin, tough, slightly flexible, 2–3 × 3–4 × 0.2–0.3 cm.; surface very finely tomentose to glabrous in zones, reddish brown behind, isabelline in front, radiate-rugose; margin thin, broadly sterile, reddish brown when dry, nearly entire: context pale isabelline, punky-fibrous, 1–2 mm. thick; tubes regular, hexagonal, very shallow in front, 1 mm. deep behind, white throughout, mouths 2 to a mm., edges rigid, entire, at first thick, becoming thinner with age.

Type collected on dead wood at Mauban, Tayabas Province, Luzon, March, 1908, by H. M. Curran, (*9593*).

FAVOLUS TENUIS (Hook.) Murrill, Bull. Torrey Club **32**: 100. 1905.

Luzon: Santa Maria Mavitac, Laguna Province, *Curran*, (*8908*), (*8910*), (*8911*), (*8913*); Lamao River, Bataan Province, *Copeland 248*; Sablan, Benguet Province, *Elmer 6141*, *6180*; Antipolo, Rizal Province, *Curran*, (*7043*); Mt. Mariveles, Bataan Province, *Copeland 158a*; Irisan, Benguet Province, *Elmer 5947*; Rizal Province, *Ramos*, (*1862*); Montalban, Rizal Province, *Merrill*, (*5090*). Camiguin: Babuyanes, *Fénix*, (*4153*), (*4156*), (*4157*). Babuyan: *Fénix*, (*3931*). Batanes: *Fénix*, (*3889*). Mindanao: Davao, *Copeland 494*, *832*; San Ramon, Zamboanga District, *Copeland*; Camp Keithley, Lake Lanao, *Clemens P*, *aw*.

FAVOLUS WIGHTII (Kl.) Ricker, Philipp. Jour. Sci. **1**: Suppl. 286. 1906.

LUZON: Lamao Forest Reserve, Bataan Province, *Curran*, (*7388*); Lamao, Bataan Province, *Curran*, (*7527*); Mt. Mariveles, Bataan Province, *Merrill*, (*3692*); Mauban, Tayabas Province, *Curran*, (*9589*); Mt. Malaraya, Tayabas Province, *Curran & Merritt*, (*8956*). Mindanao: Davao, *Copeland 635*.

FUNALIA FUNALIS (Fr.) Pat. Tax. Hymén. 95. 1900. This species is not very distinct from *Funalia villosa*.

Luzon: Bulacan Province, *Curran*, (*7181*); Twin Peaks, Benguet Province, *Elmer 6355* (specimen young and doubtfully referred to this species).

FUNALIA LEONINA (Kl.) Pat. Tax. Hymén. 95. 1900. *Polyporus Dybowskii* Pat. Bull. Soc. Myc. Fr. **8**: 53. *pl. 7. f. 6.* 1892.

Luzon: Montalban, Rizal Province, *Merrill*, (*5082*).

FUNALIA PHILIPPINENSIS Murrill, Bull. Torrey Club **34**: 469. 1907.

Luzon: Lamao, Bataan Province, *Copeland 157*.

HAPALOPILUS GILVUS (Schw.) Murrill, Bull. Torrey Club **31**: 418. 1904.

Luzon: Mt. Mariveles, Bataan Province, *Merrill*, (*3697*); Lamao River, Bataan Province, *Copeland 191*.

HAPALOPILUS LICNOIDES (Mont.) Murrill, Bull. Torrey Club **31**: 417. 1904.

Luzon: Mt. Mariveles, 230 m., Bataan Province, *Copeland 192;* Lamao, Bataan Province, *Curran,* (*7543*). Mindanao: Camp Keithley, Lake Lanao, *Clemens b, l;* Todaya, Davao, 1200 m., *Copeland 1275.*

HAPALOPILUS MALAIENSIS (Cooke) Murrill. *Polystictus malaiensis* Cooke, Grevillea **14**: 13. 1885. (Type from Perak.) This is written *P. malacensis* on the type sheet at Kew and is so printed in Saccardo. The species is easily distinguished by its large pores.

Luzon: Lamao Forest Reserve, Bataan Province, *Curran,* (*7394*); Twin Peaks, Benguet Province, *Elmer 6344.* Mindanao: Mt. Apo, 530 m., Davao, *Copeland 1155.*

**Hapalopilus Ramosii** Murrill, sp. nov.

Pileus distorted by change of position of host, new pilei appearing in an imbricate fashion on both surfaces of the now erect older sporophore, sessile, dimidiate, corky, thickest behind, becoming very thin at the margin, convex or applanate above, 2–3 × 4–5 × 0.5–1 cm.; surface anoderm, slightly uneven, azonate, finely hirtose-tomentose, fulvous; margin acute, subentire, concolorous or slightly paler, sterile: context fulvous, homogeneous, 2–4 mm. thick; tubes grayish umbrinous within, 2–4 mm. long, mouths minute, 7 to a mm., subangular, regular, glistening, changing color with the direction of the light from dark fulvous to bay, edges thin, firm, entire: spores subglobose, smooth, hyaline, 3–4 $\mu$; hyphae ferruginous, 3 $\mu$; cystidia slender, fulvous, pointed, bent at the base, scanty, 15–25 × 5–6 $\mu$.

Type collected on dead *Calophyllum Inophyllum* near Bosoboso, Rizal Province, Luzon, July, 1906, by Maximo Ramos, (*1198*).

HAPALOPILUS SUBRUBIDUS Murrill, Bull. Torrey Club **34**: 470. 1907.

Luzon: Sablan, Benguet Province, *Elmer 6134;* Mt. Mariveles, Bataan Province, *Copeland 166.* Mindanao: Camp Keithley, Lake Lanao, *Clemens ag;* San Ramon, Zamboanga, *Copeland 739.* What appears to be a young, thin form of this species was collected by Curran and Merritt, (*8970*), on Mt. Maquiling, Laguna Province, Luzon, Oct. 23, 1907.

HEXAGONA CUCULLATA (Mont.) Murrill, Bull. Torrey Club **31**: 332. 1904.

Batanes: *Fénix,* (*3887*).

**Hexagona luzonensis** Murrill, sp. nov.

Pileus flabelliform, tapering behind, 3 × 4 × 0.2–0.3 cm.; surface isabelline, becoming grayish-tinted when dry, glabrous, radiate-striate, tessellate near the margin, which is rather firm, entire, opaque, strongly inflexed on drying: context soft, white to isabelline, 1 mm. thick behind, very thin near the margin, rather fragile; tubes large, decurrent, white to discolored, 1–2 mm. long, mouths 1–2 × 1 mm., edges thin, somewhat fimbriate: stipe lateral, short, thick, white, glabrous, 5 × 5 mm.

Type collected on dead wood at Lamao, Bataan Province, Luzon, September, 1907, by H. M. Curran, (*7541*).

**Hexagona pertenuis** Murrill, sp. nov.

Pileus flabelliform, cuneate behind, 2–3 × 1.5–2.5 × 0.05 cm.; surface white, glabrous, faintly radiate-striate, tessellate near the margin, which is very thin, translucent, undulate, rarely toothed in places, fissured in age: context very thin, white, somewhat elastic when dry, but easily broken; tubes decurrent, white, becoming ochraceous, very shallow, of the usual elongated hexagonal form, mouths 0.5 × 0.25 mm., edges thin, slightly fimbriate: stipe very short, 3 mm. long, 1–2 mm. thick, lateral, cylindrical, concolorous, hardly umbilicate above.

Type collected on dead wood on Mt. Malaraya, Tayabas Province, Luzon, November, 1907, by H. M. Curran and M. L. Merritt, (*8948*).

HEXAGONA PHILIPPINENSIS (Berk.) Ricker, Phil. Jour. Sci. **1**: Suppl. 4. 287. 1906. *Polyporus philippinensis* Berk. Lond. Jour. Bot. **1**: 148. 1842. (Type from the Philippines, collected by Cuming.) *Favolus philippinensis* Sacc. Syll. Fung. 6: 393. 1888. Very similar to *P. grammocephalus* above, but tubes very much larger and elongated-hexagonal. *Leucoporus hirto-lineatus* Pat., described from Java, can hardly be different from this species, judging from the description.

Luzon: Lamao, Bataan Province, *Copeland 1407*.

**Inonotus Clemensiae** Murrill, sp. nov.

Sporophore large, imbricate, uniformly dark fulvous-brown throughout; pileus sessile, dimidiate, conchate, rigid, fragile when dry, 5–7 × 10–15 × 1–1.5 cm.; surface soft, anoderm, azonate, short-tomentose, slightly radiate-rugose; margin thick, fertile, irregularly notched or undulate: context spongy-fibrous, homogeneous, averaging 1 cm. in thickness; tubes 5 mm. long, mouths angular, 2–3 to a mm., edges thin, entire: spores ellipsoid, smooth, pale fulvous, 6–9 × 5–6 $\mu$; hyphae thick, ferruginous; cystidia none.

Type collected on dead wood at Camp Keithley, Lake Lanao, Mindanao, September–October, 1907, by Mary S. Clemens, *as*.

INONOTUS FRUTICUM (B. & C.) Murrill, Bull. Torrey Club **31**: 601. 1904.

Balabac: *Mangubat*, (*531*).

LAETIPORUS SPECIOSUS (Batt.) Murrill, Bull. Torrey Club **31**: 607. 1904.

Luzon: Mt. Isidro, Pangasinan Province, *Curran & Merritt*, (*8409*).

MICROPORELLUS DEALBATUS (B. & C.) Murrill, Bull. Torrey Club **32**: 483. 1905. *P. Adami* Berk. (type from Ceylon) and *P. rasipes* Berk. (type from the Admiralty Islands) do not appear to differ from this species.

Luzon: Mount Tapulao, Zambales Province, 1000–1400 m., *Curran & Merritt*, (*8203*). Mindanao: Camp Keithley, Lake Lanao, *Clemens*.

MICROPORELLUS SUBDEALBATUS Murrill, Bull. Torrey Club **34**: 471. 1907.

Mindanao: Zamboanga, *Whitford & Hutchinson*, (*9226*).

NIGROPORUS DURUS (Jungh.) Murrill, Bull. Torrey Club **34**: 471. 1907.

Luzon: Mauban, Tayabas Province, *Curran*, (*9588*); Santa Maria Mavitac, Laguna Province, *Curran*, (*8916*).

NIGROPORUS VINOSUS Murrill, Bull. Torrey Club **32**: 361. 1905. *Polyporus badius* Jungh. and *Polystictus Möllerianus* Sacc. are not distinct from this species. Specimens in the Bresadola herbarium are erroneously labeled *Polyporus carneo-niger* Berk, and at Berlin *Polyporus badius* Berk.

Luzon: Bosoboso, Rizal Province, *Ramos*, (*2148*); Mt. Mariveles, Bataan Province, *Merrill*, (*3695*). Mindinao: Camp Keithley, Lake Lanao, *Clemens aa*, *h*.

POLYPORUS CELEBICUS P. Henn. Monsunia **1**: 12. *pl. 1. f. 5.* 1899. It is difficult to separate this species from *P. Perula* in some of its forms, although typical examples are quite easily distinguished. Many mycologists do not consider *P. celebicus* distinct.

Luzon: Bosoboso, Rizal Province, *Ramos*, (*2154*), Rizal Province, *Ramos*, (*1861*); Santa Maria Mavitac, Laguna Province, *Curran*, (*8922*), (*8923*); Mt. Maquiling, Laguna Province, *Curran & Merritt*, (*8963*); Lamao River, Bataan Province, *Copeland 176*. Mindanao: Davao, *Copeland 489;* Trail to Mt. Apo, 1666 m., Davao, *Copeland 1066;* Camp Keithley, Lake Lanao, *Clemens bd, be.* Negros: Gimagaan River, *Copeland 6, 10.* Batanes: *Fénix*, (*3873*).

POLYPORUS CORACINUS, Murrill, Bull. Torrey Club **34**: 471. 1907.
Negros: Gimagaan River, *Copeland 18.*

POLYPORUS ELEGANS (Bull.) Fr. Epicr. Myc. 440. 1838.
Mindanao: Camp Keithley, Lake Lanao, *Clemens al.*

POLYPORUS FISSUS Berk. Lond. Jour. Bot. **6**: 318. 1847.
Luzon: Santa Maria Mavitac, Laguna Province, *Curran*, (*8914*).

POLYPORUS FLABELLIFORMIS Kl. Linnaea **8**: 483. 1833.
Luzon: Baguio, Benguet Province, *Elmer 6045.*

POLYPORUS GRAMMOCEPHALUS Berk. Lond. Jour. Bot. **1**: 148. 1842.

Negros: Gimagaan River, *Copeland 8.* Luzon: Lamao River, Bataan Province, *Copeland 160, Curran*, (*7531*); Mount Maquiling, Laguna Province, *Merrill*, (*5154*); Bosoboso, Rizal Province, *Ramos*, (*1858*), (*4622*); Sablan, Benguet Province, *Elmer 6185.* Balabac: *Mangubat*, (*532*). Mindanao, Camp Keithley, Lake Lamao, *Clemens am.*

POLYPORUS PALENSIS Murrill, Bull. Torrey Club **34**: 472. 1907.
Luzon: Sablan, Benguet Province, *Elmer 6184;* Lamao River, Bataan Province, *Copeland 153.* Negros: Gimagaan River, *Copeland 20.*

POLYPORUS PERULA (Beauv.) Fr. Epicr. 437. 1838. This species is very abundant and variable. One form of it (Luzon: Mount Maquiling, Laguna Province, *Curran & Merritt*, (*8965*)) is decidedly tomentose in appearance, with narrow glabrous zones such as occur in young specimens of *Coriolus versicolor.*

Luzon: Lamao River, 115 m., *Copeland E, 178;* Lamao River, Bataan Province, *Copeland 180;* Lamao Forest Reserve, Bataan Province, *Foxworthy, (1583)*; Mt. Mariveles, 800 m., Bataan Province, *Copeland 183;* Benguet Province, *Elmer 6146;* Baguio, Benguet Province, *Elmer 5940, 6046;* Sablan, Benguet Province, *Elmer 6133, 6182;* Santa Maria Mavitac, Laguna Province, *Curran, (8924), (8925)*; Mt. Maquiling, Laguna Province, *Merrill, (5152), Curran & Merritt, (8963), (8967), (8968)*; Bosoboso, Rizal Province, *Ramos, (2147), (2152)*; Montalban, Rizal Province, *Merrill, (5088)*; Mt. Arayat, Pampanga Province, *Merrill, (5032)*; Mt. Malaraya, Tayabas Province, *Curran & Merritt, (8943), (8961)*; Batangas Province, *Curran & Merritt, (8937)*; Mt. Tapulao, 1000–1400 m., Zambales Province, *Curran & Merritt, (8204), (8205)*; Zambales Province, *Curran & Merritt, (8209)*; Paete-Piapi, Tayabas and Laguna Provinces, *Curran, (9642), (9645)*. Palawan: Victoria Peak, *Curran, (7485), (7486), (7487)*. Batanes: *Fénix, (3878), (3882), (3886)*. Balabac: *Mangubat, (530)*. Mindoro: *Merritt, (8815)*; Mt. Halcon, *Merrill, (6115)*. Mindanao: Zamboanga, *Whitford & Hutchinson, (9236)*; Catalonan, Davao, *Copeland 926;* Mt. Apo, 2000 m., Davao, *Copeland 1154;* Davao, *Copeland 151, 707;* Camp Keithley, Lake Lanao, *Clemens ab, ad, bh, ch, cj, "K," n, o, t, z.*

PYCNOPORUS SANGUINEUS (L.) Murrill, Bull. Torrey Club **31**: 421. 1904.

Camiguin: Babuyanes, *Fénix, (4154), (4164), (4175)*. Mindanao: Camp Keithley, Lake Lanao, *Clemens bc, ci;* Davao, *Copeland C.* Negros: Gimagaan River, *Copeland 3, 7.* Balabac: *Mangubat, (537)*. Batanes: *Fénix, (3875)*. Luzon: Pangisinan Province, *Ramos, (4980)*; Montalban, Rizal Province, *Merrill, (5083)*; Bosoboso, Rizal Province, *Ramos, (1199), (2155)*; Manila, *Copeland 40;* Lamao, Bataan Province, *Curran, (7536)*; Subig, Zambales Province, *Curran, (7021), (7022)*; Santa Maria Mavitac, Laguna Province, *Curran, (8921)*; Rizal Province, *Ramos, (1863)*. Palmas: *Merrill, (5371)*.

RIGIDOPORUS SURINAMENSIS (Miq.) Murrill, Bull. Torrey Club **34**: 473. 1907.

Luzon: Mt. Maquiling, Laguna Province, *Curran & Merritt,* *(8969)*; Santa Maria Mavitac, Laguna Province, *Curran, (8917)*. Mindanao: Camp Keithley, Lake Lanao, *Clemens ai.*

**Trametes conglobata** Murrill, sp. nov.

Pileus consisting of several lobes closely imbricated in a rounded sporophore 4 × 7 × 5 cm.; lobes rigid, convex above, plane below, dimidiate, 1–2 × 1–4 × 0.5–2 cm.; surface uneven, opaque, dirty white, subglabrous, anoderm, azonate; margin obtuse, undulate, concolorous: context white or pallid, multizonate, 0.4–1.5 cm. thick; tubes about 1 mm. long, dirty white, thin-walled, mouths angular, slightly irregular, 5–6 to a mm., edges entire to undulate: spores ovoid to subglobose, smooth, hyaline, 3–4 $\mu$ long; hyphae hyaline, 3 $\mu$; cystidia none.

Type collected on deadwood at Camp Keithley, Lake Lanao, Mindanao, September–October, 1907, by Mary S. Clemens.

**Trametes insularis** Murrill, sp. nov.

Pileus sessile, dimidiate, imbricate, irregular, thickish behind, decurrent, 2–4 × 3–7 × 1–1.5 cm.; surface rugose, anoderm, glabrous, black behind, light reddish brown in front; margin obtuse, sterile, ochraceous, entire: context white to pallid, woody, zonate, 1.5–3 mm. thick; tubes 1 cm. long behind, becoming gradually shorter toward the margin, the section appearing triangular, concolorous with the context, mouths grayish-isabelline, subcircular, 3 to a mm., edges thick, firm, entire, becoming thinner at maturity: spores subglobose, smooth, hyaline, 4–5 $\mu$ long; hyphae hyaline, 3–4 $\mu$; cystidia none.

Type collected on prostrate logs of *Pinus insularis* at Baguio, 1500 m., Benguet Province, Luzon, October–November, 1905, by E. D. Merrill, *(5001)*.

TRAMETES MULLERI Berk. Jour. Linn. Soc. Bot. **10**: 320. 1868.

This species has the appearance and habit of *Daedalea*, but the tubes are never daedaleoid. *Trametes conchata* Berk., described from the Philippines, appears to be a variety of this species with sordid context and tubes, such as often occurs in *Daedalea amanitoides.*

Luzon: Zambales Province, *Curran, (7023), (7026)*; Lamao River, Bataan Province, *Copeland 165;* Bosoboso, Rizal Province, *Curran, (9527)*; Tarlac Province, *Merrill, (3602)*. Camiguin: Babuyanes, *Fénix, (4176)*. Mindanao: Camp Keithley, Lake Lanao, *Clemens an* and one other collection.

**Tyromyces Merrittii** Murrill, sp. nov.

Pileus imbricate-multiplex, the lobes few in number and attached together in a prolonged stipitiform base, each lobe flabelliform, with cuneate base, 7–9 × 7–9 × 0.5 cm.; surface radiate-rugose and roughened with prominences of various sizes, sordid white, opaque, very minutely tomentose; margin irregular, variously lobed, rather thick, fertile, slightly deflexed: context fleshy-fibrous, very brittle when dry, milk-white, 2 mm. thick; tubes 3 mm. long, slender, nearly white within, mouths grayish-white, glistening, discolored in places, regular, thin-walled, 3 to a mm., edges firm, entire: spores ovoid, curved, smooth, hyaline, 5–6 × 3 $\mu$; hyphae very fragile, hyaline, 4–5 $\mu$; cystidia none.

Type collected on dead wood on Mt. Maquiling, Batangas Province, Luzon, November, 1907, by H. M. Curran and M. L. Merritt, (*8939*).

**Tyromyces subchioneus** Murrill, sp. nov.

Pileus sessile, dimidiate, applanate, fleshy-tough to fragile, 2 × 4 × 0.2 cm.; surface smooth, glabrous, grayish isabelline, wrinkled when dry; margin entire, thin, sterile and abruptly deflexed: context white, homogeneous, fragile, 1 mm. thick when dry; tubes very distinct from the context in color, dark yellowish gray within, 1 mm. long, mouths subcircular, regular, grayish, glistening, 5–6 to a mm., edges entire, thick at first, becoming thinner at maturity: spores oblong, ellipsoid, smooth, hyaline, 5–6 × 2 $\mu$; hyphae hyaline, 3–4 $\mu$; cystidia none.

Type collected on dead wood on Mt. Apo, 2160 m., Davao, Mindanao, April 20, 1904, by E. B. Copeland, *1074*.

**Tyromyces unguliformis** Murrill, sp. nov.

Pileus compressed-ungulate, plane below, much thicker behind, 5 × 8 × 1–3 cm.; surface anoderm, azonate, somewhat tuberculose, nearly glabrous, milk-white, opaque; margin abruptly acute, narrowly sterile, concolorous, entire: context white, fragile when dry, homogeneous, 5–8 mm. thick; tubes white or yellowish within, 1 cm. long behind, gradually shorter towards the margin, slender, mouths circular, regular, 4 to a mm., somewhat glistening, white with a silvery sheen, edges thick, entire: spores smooth, ovoid, hyaline, 3 × 2 $\mu$; hyphae hyaline, 3 $\mu$; cystidia none.

Type collected on dead wood on Balabac Island, March–April, 1906, by L. Mangubat, (*533*).

**Whitfordia** Murrill, gen. nov.

Hymenophore annual, epixylous, stipitate; surface glabrous, anoderm: context brown, fibrous to corky; tubes minute, cylindrical: spores hyaline: stipe lateral, black.

Type species, *Fomes Warburgianus* P. Henn.

**Whitfordia Warburgiana** (P. Henn.) Murrill. *Fomes Warburgianus* P. Henn.; Monsunia **1**: 10. *pl. 1. f. 3.* 1900. *Coriolopsis aneba* (Berk.) Murrill, Bull. Torrey Club **34**: 466. 1907. Specimens sent in previously were too young and aborted to determine accurately. The context of this species is rather pale when young, becoming blacker with age.

Lumbacan: *Merrill, (5280)*. Negros: Gimagaan River, *Copeland 12, 17*. Luzon: Mount Maquiling, Laguna Province, *Merrill, (5150)*. Mindoro: Bongabong River, *Whitford 1436*. Mindanao: Sibulan River, Davao, *Copeland 1308;* Malita, Davao, *Copeland 655*.

## Tribe FOMITEAE

**Amauroderma asperulatum** Murrill, sp. nov.

Pileus reniform to nearly circular, thick, corky, rigid, convexo-concave, 5 cm. in diameter, 1.5 cm. thick; surface glabrous, avellaneous with two or three dark brown zones, thinly encrusted, neither laccate nor shining, rugose when dry; margin thick, undulate, sulcate: context thin, 1–2 mm., white, punky-fibrous, homogeneous; tubes very long and slender, 1–1.5 cm., wood-brown, mouths angular, 3 to a mm., edges thin, entire: spores copious, ovoid, deep yellowish brown, averaging $18 \times 12\,\mu$, studded with immense warts: stipe ascending, laterally attached, cylindrical, equal, slightly expanding above, resembling the pileus in surface, harder in substance, 5 cm. long, 6–7 mm. thick.

Type collected on the base of dead *Parkia* (?), at Lamao, Bataan Province, Luzon, February 2, 1904, by E. B. Copeland.

**Amauroderma bataanense** Murrill, sp. nov.

Pileus circular in outline, nearly plane, rigid, corky, 5 × 5 × 0.5 cm.; surface much wrinkled both concentrically and radially in drying, sulcate, faintly zonate, opaque, avellaneous to grayish brown, paler toward the margin, thinly encrusted, glabrous; margin undulate, truncate; context white or nearly so, 3 mm. thick at the center, very thin at the margin, homogeneous, firm; tubes fuscous-brown within and without, 2–3 mm. long, mouths rather large and angular at maturity, 3 to a mm., edges thin, firm, entire: spores globose, very deep brown, thick-walled, lightly asperulate, copious, 12–14 $\mu$: stipe central, subcylindrical, enlarged at the surface of the ground, tapering and radicate below, corticated, isabelline, woody, 6 × 0.6 cm.

Type collected on decaying underground roots in the region of Lamao, Bataan Province, Luzon, September, 1907, by H. M. Curran, (*7528*).

**Amauroderma Clemensiae** Murrill, sp. nov.

Pileus thin, tough, flexible, flabelliform to subcircular, conchate, deeply depressed behind, 5 × 6 × 0.2–0.3 cm.; surface glabrous, nearly smooth, multizonate, faintly radiate-rugose when dry, brown behind, avellaneous in front, with darker zones; margin very thin, entire to undulate, blackish and inflexed on drying: context punky-fibrous, pale isabelline, 0.5–1.5 mm. thick; tubes 1.5–2.5 mm. long, pallid within, mouths avellaneous, umbrinous when bruised, regular, glistening 4–5 to a mm., edges thin, entire, corky: spores subglobose to ovoid, smooth, faint yellowish brown, copious, 5–7 $\mu$: stipe exactly lateral, curved, cylindrical, nearly even, slightly enlarged at the base and somewhat compressed where it joins the pileus, resembling the pileus in surface and context, but uniformly light brown in color and almost woody, 8 × 0.6–0.7 cm.

Type collected on dead roots near Camp Keithley, Lake Lanao, Mindanao, September–October, 1907, by Mary S. Clemens.

AMAURODERMA ELMERIANUM Murrill, Bull. Torrey Club **34**: 475. 1907.

Mindanao: Zamboanga, *Whitford & Hutchinson*, (*9288*).

**Amauroderma Ramosii** Murrill, sp. nov.

Pileus round-reniform, deeply incised at the hilum, where the stipe is attached, rigid, corky, slightly convex, 3 × 4 × 0.5 cm.; surface thinly encrusted, opaque, glabrous, very slightly sulcate-zonate, dark gray or blackish, much wrinkled on drying; margin thick, obliquely truncate, delicately penciled, undulate: context 1–2 mm. behind, very thin in front, nearly white, punky-fibrous; tubes 4–5 mm. long, slender, avellaneous, mouths concolorous or darker, regular, circular, 5 to a mm., edges very thick, entire: spores subglobose, finely asperulate, light yellowish brown, 8–10 $\mu$: stipe laterally attached, suberect, curved and somewhat compressed, corticated, glabrous, paler than the pileus, woody, radicate and branched below, 7 × 0.4 cm.

Type collected on dead roots near Bosoboso, Rizal Province, Luzon, July, 1906, by Maximo Ramos, (*1211*).

ELFVINGIA ELMERI Murrill, Bull. Torrey Club **34**: 476. 1907.

Luzon: Subig, Zambales Province, *Curran*, (*7024*). Mindanao: Camp Keithley, Lake Lanao, *Clemens ar* and one other collection.

ELFVINGIA TORNATA (Pers.) Murrill, Bull. Torrey Club **30**: 301. 1903. *Ganoderma subtornatum* Murrill is probably only a form of this species having an excess of resin. The two genera come very close together here.

Mindanao: Davao, Copeland *380, 500*; Todaya, Davao, 1400 m., *Copeland*, 900 m., *Copeland 1223*; Camp Keithley, Lake Lanao, *Clemens i, y*, and one other collection. Luzon: Mount Maquiling, Laguna Province, *Merrill*, (*5155*); Bosoboso, Rizal Province, *Ramos*, (*1193*), (*1209*), (*1216*); Mt. Mariveles, *Copeland 167, 190*; Mt. Malaraya, Tayabas Province, *Curran & Merritt*, (*8944*); Zambales Province, *Curran & Merritt*, (*8203*); Rizal Province, *Foxworthy*, (*137*); Montalban, Rizal Province, *Merrill*, (*5087*); Lamao Forest Reserve, Bataan Province, *Curran*, (*7387*); Panai, Benguet Province, *Elmer*, (*5002*); Lamao River, Bataan Province, *Copeland 181, 189, 193*; Baguio, Benguet Province, *Elmer 6069*; Santa Maria Mavitac, Laguna Province, *Curran*, (8932). Balabac: *Mangubat*, (*536*). Camiguin: Babuyanes, *Fénix*, (*4169*), (*4173*), (*4178*). Palmas: *Merrill*, (*5370*).

FOMES AUBERIANUS (Mont.) Murrill, Bull. Torrey Club **32**: 491. 1905.

Mindanao: Camp Keithley, Lake Lanao, *Clemens au, bg*, and one other collection. Negros: Gimagaan River, *Copeland 13*.

FOMES LIGNEUS (Berk.) Cooke, Grevillea **13**: 119. 1884.

Mindanao: Camp Keithley, Lake Lanao, *Clemens* "*Q*".

FOMES LUZONENSIS Murrill, Bull. Torrey Club **34**: 476. 1907.

Luzon: Mt. Mariveles, Bataan Province, *Copeland 182*, on living *Dipterocarpus*. These specimens are too young to show typical surface markings or a stratified hymenium.

FOMES UNGULATUS (Schaeff.) Sacc. Syll. Fung. **6**: 167. 1888.

Luzon: Baguio, Benguet Province, *Elmer 5945*. No. 5238 (Luzon: Baguio, Benguet Province, *Curran*) appears to be a young and much discolored specimen of this species.

**Fomes subresinosus** Murrill, sp. nov.

Pileus semicampanulate, attached by an elongated umbo, concave below, woody, 6 × 8 × 1 cm.; surface glabrous, somewhat resinous, thinly encrusted, very rugose when dry, slightly sulcate, conspicuously banded with broad brown and shining-black zones; margin thick, abruptly acute and deflexed, entire or undulate, concolorous: context white, slightly pallid when dry, woody-fibrous, 3–5 mm. thick; tubes 5–8 mm. long, slender, brownish flesh-colored within when dry, mouths circular and whitish when young, becoming angular and concolorous at maturity, 3–4 to a mm., edges at first thick, becoming thin and lacerate: spores globose or subglobose, smooth, hyaline, 3–4 $\mu$; hyphae hyaline; cystidia none.

Type collected on dead wood in the Lamao Forest Reserve, Bataan Province, Luzon, October, 1906, by F. W. Foxworthy, (*1628*). Also collected at Bosoboso, Rizal Province, Luzon, July, 1906, by Maximo Ramos, (*1215*).

**Fomes subungulatus** Murrill, sp. nov.

Pileus sessile, dimidiate, broadly attached, the point of attachment bounded by a narrow black zone, rigid, convex above, concave below, 6 × 8 × 1–2 cm.; surface sulcate, glabrous, anoderm, slightly tuberculose, isabelline, suffused in places with reddish brown; margin rounded, thick, entire: context thick, 5–8 mm., isabelline, zonate, soft-corky; tubes whitish within, slender, 3–5 mm. long, not distinctly stratified, mouths small, white to isabelline, perfectly circular, 5 to a mm., edges thick, obtuse, entire: spores ovoid, smooth, hyaline, 5 × 3.5 $\mu$; hyphae hyaline, 5–6 $\mu$; cystidia none.

Type collected on prostrate logs of *Pinus insularis* at Baguio, 1500 m., Benguet Province, Luzon, October–November, 1905, by E. D. Merrill, (*5005*).

GANODERMA AMBOINENSE (Lam.) Pat. Bull. Soc. Myc. Fr. **5**: 70. 1889.

Luzon: Lamao Forest Reserve, Bataan Province, *Curran*, (*7395*); Lamao, Bataan Province, *Copeland 1365;* Bosoboso, Rizal Province, *Ramos*, (*2157*). Negros: Gimagaan River, *Copeland 16*.

**Ganoderma balabacense** Murrill, sp. nov.

Pileus ascending from a short, thick tubercle, flabelliform to nearly circular, depressed at the center or behind, very concave below, 15 × 15 × 2 cm.; surface glabrous, thinly encrusted, opaque brown behind, laccate, shining and dark reddish brown in front, rugose and roughly tuberculose, sulcate; margin abruptly acute, yellowish, sterile, entire: context ferruginous above, fulvous below, woody-fibrous, 1 cm. thick; tubes cinereous-fuscous, slender, 1 cm. long, mouths circular, regular, 3–4 to a mm., whitish when young, concolorous at maturity, edges thick, entire: spores ovoid, finely asperulate, pale brownish, 8–9 × 4–5 μ; hyphae ferruginous-fulvous; cystidia none.

Type collected on the island of Balabac, March–April, 1906, by L. Mangubat, (*539*).

**Ganoderma Currani** Murrill, sp. nov.

Pileus corky, rigid, reniform, convex above, concave below, slightly depressed behind, attached at the hilum to a very long stipe, 3–4 × 5–6 × 0.5 cm.; surface glabrous, laccate, shining, reddish brown, shallowly concentrically sulcate, radiate-rugose; margin thick, undulate, concolorous: context fulvous, punky, 1–2 mm. thick; tubes slender, 3–4 mm. long at the thickest part of the pileus, grayish fuscous, mouths becoming concolorous, circular to angular, 4–5 to a mm.: spores ovoid, distinctly asperulate, deep fulvous, copious, 8–10 × 6–7 μ: stipe erect, sublaterally attached, nearly cylindrical, slightly irregular, equal, laccate, glabrous, encrusted, 15–20 cm. long, 5–10 mm. thick.

Type collected on dead wood at Lamao, Bataan Province, Luzon, September, 1907, by H. M. Curran, (*7544*).

NIGROFOMES MELANOPORUS (Mont.) Murrill, Bull. Torrey Club **31**: 425. 1904.

Luzon: Lamao, Bataan Province, *Curran*, (*7540*).

PYROPOLYPORUS ALBOMARGINATUS (Lév.) Murrill, Bull. Torrey Club **34**: 478. 1907. *Polyporus ochrocroceus* P. Henn. (Monsunia **1**: 145. 1899.) exactly corresponds to this species, judging from the description, and should be treated as a synonym.

Luzon: Bosoboso, Rizal Province, *Ramos*, (*2149*), (*2150*), (*2156*); Lamao River, Bataan Province, *Copeland 173*; Mt. Mariveles, Bataan Province, *Merrill*, (*3698*). Mindanao: Mt. Apo, Davao, *Copeland 1077*. A specimen collected at Camp Keithley by Mrs. Clemens agrees well with *Fomes pyrrhocreas* Cooke, which I have considered synonymous with *P. albomarginatus*. It may be that further collections will prove them distinct species.

PYROPOLYPORUS CALIGINOSUS (Berk.) Murrill, Bull. Torrey Club **34**: 478. 1907.

Mindanao: Camp Keithley, Lake Lanao, *Clemens ak, d, f.*

PYROPOLYPORUS ENDOTHEIUS (Berk.) Murrill, Bull. Torrey Club **34**: 478. 1907. *Pyropolyporus Williamsii* Murrill, Bull. Torrey Club **34**: 479. 1907. A quantity of good material shows gradations between the two forms distinguished as species in a former paper. When young the context is bright-colored, becoming darker and thinner with age.

Mindoro: Mt. Halcon, *Merrill*, (*6120*). Camiguin: Babuyanes, *Fénix*, (*4177*). Mindanao: Camp Keithley, Lake Lanao, *Clemens cf*, and one other collection. Luzon: Montalban, Rizal Province, *Merrill*, (*5089*); Bosoboso, Rizal Province, *Curran*, (*9526*); Mt. Malaraya, Tayabas Province, *Curran & Merritt*, (*8950*).

PYROPOLYPORUS FASTUOSUS (Lév.) Murrill, Bull. Torrey Club **34**: 479. 1907.

Mindoro: Mt. Halcon, *Merrill*, (*6114*). Luzon: Antipolo, Rizal Province, *Curran*, (*7044*). Camiguin: Babuyanes, *Fénix*, (*4171*). Mindanao: Zamboanga, *Whitford & Hutchinson*, (*8942*); Camp Keithley, Lake Lanao, *Clemens bi, p, u, x.*

PYROPOLYPORUS LAMAENSIS Murrill, Bull. Torrey Club **34**: 479. 1907.

Luzon: Mt. Mariveles, Bataan Province, *Copeland 145.* Negros: Gimagaan River, *Copeland 15.* Mindanao: Catalonan, Davao, *Copeland 922.*

PYROPOLYPORUS PECTINATUS (Kl.) Murrill, Bull. Torrey Club **34**: 479. 1907. *Fomes substygius* B. & Br., from Ceylon, is considerably larger than the usual form of this species, but it does not appear to be specifically distinct. *Polyporus Hasskarlii* Lév., described from Java in 1844, is identical with Klotsch's species described from the East Indies eleven years previously.

Luzon: Santa Maria Mavitac, Laguna Province, *Curran*, (*8912*); Lamao, Bataan Province, *Curran*, (*7520*). Palawan: Ewiig River, *Merrill*, (*3586*).

**Pyropolyporus subextensus** Murrill, sp. nov.

Pileus large, woody, sessile, dimidiate, applanate, slightly convex below, 7–8 × 10–12 × 1 cm.; surface rough, slightly sulcate, glabrous, thinly encrusted, opaque brown; margin slightly lobed, very obtuse, fulvous, sterile: context ferruginous, multizonate, woody, nearly 1 cm. thick; tubes short, 1–2 mm. long each season, fulvous in older layers, grayish fuscous in those of recent growth, mouths minute, fulvous, circular, thick-walled, 7–8 to a mm., edges thick, entire: hyphae ferruginous, 3–4 $\mu$; cystidia flask-shaped or irregular in outline, pointed, fulvous, very abundant, 15–30 $\mu$ long, 8–10 $\mu$ thick at the base.

Type collected on dead wood at Camp Keithley, Lake Lanao, Mindanao, September, 1907, by Mary S. Clemens. Also collected on Mt. Apo, 2000 m., Davao, Mindanao, April 22, 1904, by E. B. Copeland, "*E.*"

**Pyropolyporus tenuissimus** Murrill, sp. nov.

Pileus thin, woody, rigid, dimidiate, concave above, convex below, decurrent behind, 1–1.5 × 4–5 × 0.1–0.2 cm.; surface rough, spongy-tomentose to subglabrous, neither sulcate nor zonate, fulvous to fuliginous, thicker and more spongy near the margin, which is fulvous, finely tomentose, rather thick, undulate: context fulvous, very thin, punky to corky; tubes stratified, 0.5 mm. or less long each season, cinereous-fuscous within, mouths whitish-stuffed when young, minute, 6 to a mm., circular, regular, avellaneous at first, becoming darker at maturity, edges thick, entire: spores globose, smooth, hyaline, copious, 3–4 $\mu$; hyphae melleous, 2–3 $\mu$; cystidia fulvous, cuspidate, scanty, 15–20 $\mu$ long, 5–7 $\mu$ thick at the base.

Type collected on dead wood in Davao, Mindanao, March 13, 1904, by E. B. Copeland, *497*.

**Pyropolyporus tricolor** Murrill, sp. nov.

Pileus very large, applanate, comparatively thin, rigid, woody, 15 × 25 × 1–2 cm.; surface roughly tuberculose and ridged, irregularly sulcate, thinly encrusted, glabrous, dark brown to dull black, rimose in dried specimens; margin thin, obtuse, reddish, subentire: context woody, brick-red, with white dendroid markings, 5–8 mm. thick; tubes 4–5 mm. long each season, brick-red in the older layers, yellowish red with white lines in recent growths, mouths minute, regular, circular, glistening, melleous, 4 to a mm., edges rather thick, entire: spores subglobose, smooth, hyaline, with smoky brownish, rather thin walls, 5–6 $\mu$; hyphae melleous, 3–4 $\mu$; cystidia none.

Type collected on dead wood at Santa Maria Mavitac, Laguna Province, Luzon, February, 1908, by H. M. Curran, (*8933*).

### Tribe DAEDALEAE

CYCLOMYCES FUSCUS Fr. Linnaea **5**: 512. *pl. 11. f. 3.* 1830. (Type from Mauritius.)

Luzon: Mt. Malaraya, Tayabas Province, *Curran & Merritt*, (*8949*); Benguet Province, *Elmer 6048*.

DAEDALEA AMANITOIDES Beauv. Fl. Owar. 1: 44. 1805.

Luzon: Mt. Malaraya, Tayabas Province, *Curran & Merritt*, (*8945*), (*8953*); Bosoboso; Rizal Province, *Ramos*, (*1191*), (*1207*), (*4619*), (*4623*); Rizal Province, *Ramos*, (*1867*); Bagac, Bataan Province, *Curran*, (*6494*); Lamao Forest Reserve, Bataan Province, (*7389*); Lamao, Bataan Province, *Curran*, (*7542*); Panai, Benguet Province, *Merrill*, (*5004*); Montalban, Rizal Province, *Merrill*, (*5091*); Twin Peaks, Benguet Province, *Elmer 6354*. Negros: Gimagaan River, *Copeland 21*. Mindoro: Bongabong River, *Whitford 1443*. Mindanao: Davao, *Copeland 490*; Camp Keithley, Lake Lanao, *Clemens g*, *m*, and one other collection.

DAEDALEA HOBSONI Berk. Jour. Linn. Soc. Bot. **13**: 165. 1873.

Balabac: *Mangubat*, (*510*). Luzon: Bagac, Bataan Province, *Curran*, (*6493*); Montalban, Rizal Province, *Merrill*, (*5084*); Moron, Bataan Province, *Curran*, (*6492*); Lamao, Bataan Province, *Copeland 186, 187, 188*; Bauang, Union Province, *Elmer 5745*; Santa Maria Mavitac, Laguna Province, *Curran*, (*8920*), (*8931*); Cavite Province, *Curran & Merritt*, (*8941*); Zambales Province, *Curran*, (*7027*); Mt. Mariveles, Bataan Province, *Merrill*, (*3696*); Rizal Province, *Foxworthy*, (*119*), *Ramos*, (*1868*); Antipolo, Rizal Province, *Curran*, (*7041*); Manila, *Copeland 42*. Mindoro: Bongabong River, *Whitford 1419*. Mindanao: Zamboanga, *Whitford & Hutchinson*, (*9225*); Camp Keithley, Lake Lanao, *Clemens* "*O*," *q*.

**Daedalea isabellina** Murrill, sp. nov.

Pileus thin, corky, slightly flexible, sessile, dimidiate, applanate above, convex below, thickest behind, 5 × 9 × 0.5–1.5 cm.; surface glabrous, faintly multizonate in front, rough and warty behind, somewhat radiate-rugose, isabelline; margin thin, undulate, subconcolorous: context homogeneous, corky, isabelline, 1–2 mm. thick; hymenium very irregular, porose-daedaleoid behind and lamellate nearly to the margin, where the furrows are forked or additional ones inserted and the edges are thick and close; furrows mostly radial, thin-walled, 1–1.5 mm. wide, 1.3 cm. deep behind, becoming gradually shallower towards the margin, edges entire or undulate, some of them splitting into broad, flat plates with sharply toothed lower margins: spores ovoid, smooth, hyaline, copious, 5–6 × 3–4 $\mu$; hyphae slightly yellowish, 3–4 $\mu$; cystidia none.

Type collected on dead wood at Sablan, Benguet Province, Luzon, April, 1904, by A. D. E. Elmer, *6186*.

**Daedalea subconfragosa** Murrill, sp. nov.

Pileus sessile, reniform, thin, flexible, conchate, 6 × 11 × 0.3 cm.; surface glabrous, faintly multizonate, pale wood-color; margin acute, fertile, concolorous, entire or undulate: context ochraceous, punky, less than 1 mm. thick; tubes pale wood-color within and without, 2–3 mm. long, tough, mouths much elongated radially, variable in size, 1–6 × 0.5–1 mm., edges thin, undulate or irregularly toothed: spores ellipsoidal, smooth, hyaline, 5–6 × 3–4 $\mu$; hyphae hyaline, 3–4 $\mu$; cystidia none.

Type collected on dead wood in Rizal Province, Luzon, January, 1906, by F. W. Foxworthy, (*22*).

GLOEOPHYLLUM EDULE Murrill, Bull. Torrey Club **34**: 480. 1907.

Luzon: Baguio, Benguet Province, *Elmer*, *Merrill*, (*5000*); Trinidad, Benguet Province, *Elmer 5942*; Zambales Province, *Curran*, (*7019*).

**Gloeophyllum nigrozonatum** Murrill, sp. nov.

Pileus rigid, subtriangular, narrower behind, sessile, convex above, plane below, 7 × 6 × 1–2 cm.; surface glabrous, nearly smooth, cinereous behind, isabelline in front, with a broad black zone one third the distance from the point of attachment and two or three indistinct brownish zones near the margin, which is thick, rounded, sterile, faintly tomentose, subentire, isabelline or slightly avellaneous: context ferruginous, corky, homogeneous, 5 mm. thick; tubes 1 mm. long behind and at the center, avellaneous, with fulvous dissepiments, mouths ferruginous to cinereous-fuscous, very uneven and irregular in size and shape, daedaleoid and 1–2 × 2–5 mm. behind, with irpiciform edges, poroid and 1 mm. or less at the margin, with edges entire: spores ovoid, smooth, hyaline, scanty, 5 × 3.5 $\mu$; hyphae ferruginous, 3 $\mu$; cystidia none.

Type collected on dead wood near Baguio, Benguet Province, Luzon, March, 1904, by A. D. E. Elmer, *5941*.

GLOEOPHYLLUM STRIATUM (Sw.) Murrill, Bull. Torrey Club 32: 370. 1905.

Mindanao: Davao, *Copeland D, 525*. Negros: Gimagaan River, *Copeland*.

**Lenzites Clemensiae** Murrill, sp. nov.

Pileus flabelliform, applanate above, convex below, very slightly flexible, tapering to a very small point of attachment behind, 6 × 7 × 1–1.5 cm.; surface marked with a few broad concentric furrows, minutely reticulated, pure white and regularly radiate-grooved on the marginal band 1.5 cm. broad, grayish-discolored and almost devoid of reticulations and grooves behind; margin subentire, very thick, the context projecting so as to form a very slight edge above the rounded ends of the gills: context milk-white, 1 mm. thick; furrows very deep, reaching 1 cm. or more, most of them forked once, 2 mm. broad, dissepiments entire, obtuse, firm, slightly cremeous.

Type collected on dead wood at Camp Keithley, Lake Lanao, Mindanao, September, 1907, by Mary S. Clemens, *cc*.

**Lenzites submurina** Murrill, sp. nov.

Pileus thin, tough, slightly flexible, dimidiate, sessile, applanate above and below, 5 × 9 × 1 cm.; surface glabrous, narrowly sulcate and avellaneous-isabelline in front, broadly sulcate and murinous behind; margin thin, undulate: context white, very distinct in color from the isabelline dissepiments, very thin at the margin, increasing to 3 mm. thick behind; furrows lamellate, 1 mm. wide, reaching 5 mm. in depth, edges entire or slightly undulate, not splitting with age.

Type collected on dead wood at Camp Keithley, Lake Lanao, Mindanao, September–October, 1907, by Mary S. Clemens, *aj*.

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# BOLETI FROM WESTERN NORTH CAROLINA

By WILLIAM ALPHONSO MURRILL

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# BOLETI FROM WESTERN NORTH CAROLINA

By WILLIAM A. MURRILL

It was my privilege to spend two weeks during the past summer with Dr. C. A. Schenck, Forester of the Biltmore Estate, in Pisgah Forest, Transylvania Co., North Carolina, about fifty miles southwest of Asheville. Dr. Schenck's summer home is in Pink Bed Valley, 3,200 ft. above sea level, with surrounding ridges reaching a maximum elevation of 4,500 ft. The forest there is mostly composed of hardwood species, chestnut, oak, and tulip predominating, while pitch pine is found sparingly on the dry ridges and hemlock and white pine along the streams. Maple, birch, hickory, basswood, sourwood, black gum, black locust, butternut, ash, and Fraser's magnolia also occur as minor hardwood species. *Rhododendron*, *Kalmia*, and *Azalea* are exceedingly abundant, in many places forming impenetrable thickets which, when in flower, are visible from a distance as pink-colored masses or "beds."

About the middle of July, when I arrived at Pink Bed Valley, frequent showers had developed quantities of fleshy fungi, among them many boleti, which were collected and critically studied in the fresh condition, and afterwards dried by artificial heat. Dr. H. D. House very kindly assisted me in collecting, and the fact that several interesting species are represented by more than one or two specimens in this collection is largely due to his perseverance.

The following list includes practically all the species of Boletaceae collected during my stay in Pink Bed Valley arranged in alphabetical order under the generic and specific names commonly recognized in this country.

BOLETINUS PICTUS Peck.

Collected twice in considerable quantity, once in swampy ground and once on a dead locust log in low woods.

This species has the large radiating tubes of the genus *Boletinus*, and is easily distinguished among the Boletaceae by the conspicuous red scales that adorn its pileus and stem. It is fairly common in the woods and mossy swamps of the mountainous regions of the eastern United States. Edible.

BOLETUS AMERICANUS Peck.

Common, especially near pines.

This is a common and widely distributed edible species having a yellow, viscid cap usually dotted or streaked with red and a slender yellow stem covered with reddish brown viscid dots which become black on drying.

BOLETUS AURIFLAMMEUS B. & C.

Five specimens were collected on a well-drained bank exposed to the sun about two hours just after midday. Dr. House afterwards sent me a number of fine specimens.

This species is of great interest, being very rare and very beautiful. It was originally collected in North Carolina by Rev. M. A. Curtis and sent by him to Berkeley, who described it. Peck found one plant at Sandlake, New York, and it was also reported by Beardslee from Brookside, West Virginia. The description given by Berkeley is both incomplete and inaccurate, but the bright golden yellow color of the pileus and stem should easily distinguish it. The mouths of a few of the tubes sometimes appear scarlet, especially on drying, but this character is not at all conspicuous. The stem is beautifully reticulated.

BOLETUS AURIPORUS Peck.

Occasional on banks and in open woods.

This species may be easily recognized by its bright golden yellow tubes which retain their color on drying. The cap is usually reddish brown and the stem is viscid if the weather is not too dry. Edible.

BOLETUS BICOLOR Peck.

Several times collected on banks and in thin woods.

A beautiful species, with smooth purplish-red cap, bright yellow tubes, and smooth, red, or yellow stem. When broken both flesh and tubes change to blue. This plant has been reported from only a few localities. Beardslee reported it very common in the mountains of West Virginia. Edible.

Boletus castaneus Bull.

Rare in sandy soil in open woods.

This species has a hollow stem and dries easily. The cap is reddish brown, the flesh white and unchangeable, and the free tubes are at first white then yellowish. It is widely distributed and usually common. Edible.

Boletus chromapes Frost.

Very abundant in open woods throughout the valley and on the adjoining slopes.

A very attractive species, and one easily recognized by its stem, which is bright yellow near the base and finely scabrous over its entire surface. The cap is pale red and the tubes and most of the stem white. Edible.

Boletus chrysenteron Fries.

Found a few times on roadside banks.

This species is widely distributed and usually common. The cap and stem are usually red and the tubes yellow and large. It dries easily, being spongy-tomentose in texture. The surface of the cap is soft, finely floccose, and often cracked. Edible.

Boletus cyanescens Bull.

Rather common in open woods, at times solitary, but usually gregarious.

A common and widely distributed plant easily known by the deep blue color which its flesh and tubes assume when wounded. The cap is pale tan and floccose-tomentose, the tubes and hollow stem white or pallid. It dries very readily.

Boletus eximius Peck.

Several times collected in thin woods and along roadsides.

The stem of this species is very characteristic, being lilac-gray and furfuraceous, while the cap and tubes are chocolate-brown. This species has been rarely reported, but I have it from New

England, New York, and Virginia, as well as from North Carolina.

BOLETUS FELLEUS Bull.

Collected only once or twice, but probably common later.

This abundant and widely distributed plant is easily known by the bitter taste of its flesh. The tubes are flesh-colored and the cap usually some shade of brown. When fully grown, it is sometimes over a foot in diameter. Said to be poisonous.

BOLETUS FUMOSIPES Peck.

Rather common on shaded roadside banks.

This species has been almost unknown except to Professor Peck, who described it in 1898 from material collected at Port Jefferson, Long Island. Professor Atkinson found it in abundance in North Carolina, and I collected it also in Virginia. It is peculiar in having a pale bluish green band at the top of the stipe. The cap is also very reticulate-rimose, and the tubes an unusual grayish white, afterwards discolored by the deep ochraceous-brown spores. When once seen, it is difficult to confuse it with any other species.

BOLETUS GRACILIS Peck.

Collected three or four times, but only one plant was found on each occasion.

This species is not generally well known, although said to be abundant in some localities. It belongs to a small group having flesh-colored spores, which tinge the white tubes at maturity. *B. felleus*, *B. indecisus*, and *B. nigrellus* are large plants with thick stems, from which *B. gracilis* is easily distinguished by its slender habit and small size.

BOLETUS GRANULATUS L.

Common, preferring open places in woods, and found more abundantly near pines.

This species is quite common in the eastern United States, usually appearing in scattered groups near pine trees. The cap is very slimy and brownish when moist, changing to yellow on partial drying; the tubes and stem are yellowish, with viscid dots which become black on drying. It is rather easy to confuse this species with *B. americanus*. Edible.

BOLETUS GRISEUS Frost.

Quite common in open places in woods.

This species is very similar to *B. retipes*, but is easily distinguished in the field by its pure white tubes, those of *B. retipes* being decidedly yellow. The cap is gray and the stem usually whitish. Edible.

BOLETUS INDECISUS Peck.

One of the most common species, occurring in clusters and colonies especially in clayey soil along the edges of exposed roads and trails.

This species is closely related to *B. felleus*, from which it is distinguished by its mild taste, that of *B. felleus* being decidedly bitter.

BOLETUS LURIDUS Fries.

Collected in abundance, especially on clay banks along roads.

This species, said to be very poisonous, may be at once distinguished from the other species mentioned here by the reddish-orange mouths of its tubes, the interior of the tubes being yellow. When cut, the entire cut surface of cap, tubes, and stem changes at once to blue. All boleti with red or reddish tube-mouths should be avoided when collecting mushrooms for food.

BOLETUS LUTEUS L.

Collected three times in open sandy soil in woods.

Cap very viscid, yellowish brown ; tubes and stem yellow, the latter dotted and also provided with a large white annulus. This is a well-known and widely distributed edible species commonly found in coniferous woods.

BOLETUS MINIATO-OLIVACEUS Frost.

Rather common in open woods near roads and trails.

Cap vermilion, tubes bright yellow, stem yellow with pink markings. This species is easily distinguished among the red boleti by its quick change to blue at any point, either outside or inside, where bruised or even touched with the fingers. It is reported from New England south to West Virginia, and is said to be poisonous.

Boletus Morgani Peck.

A single fine specimen was collected by Dr. Schenck on one of the mountain trails. After my departure Dr. House found several specimens, which he sent to the Garden Herbarium. Dr. Harper also collected it recently in Georgia.

This is a rare species, described from Kentucky and found in Virginia and one or two other states. Cap viscid, smooth, perfectly glabrous, shining testaceous; tubes flavous, becoming greenish from the spores ; stem very long and rough with deep reticulations, flavous above, purplish-stained below. The long rough stem should distinguish it from all other boleti except *B. Russellii*, which differs in having a dry, tomentose cap.

Boletus Peckii Frost.

One of the most common species, usually along the roads in rather open woods.

Easily recognized by its red cap with a bloom like that of a peach. The tubes and upper part of the stem are yellow, the remainder of the stem red, and the whole surface reticulated. The stem of *B. speciosus* is entirely yellow and that of *B. bicolor* is not reticulated. Reported edible.

Boletus Ravenelii B. & C.

About ten plants were collected in all, some of them very fine. Dr. House later found many more. This was one of the few species that preferred the deep shade of the mountain laurel.

Cap dull reddish, both it and the stem covered with a light yellow powder, by which the plant is readily distinguished. The conspicuous veil was found more than once covered with a print of the olive-green spores. As the stem elongates, part of the veil remains attached to the margin of the cap and part forms a clinging cortina on the stem. I tasted the flesh and found it sweet. This beautiful species has been several times reported in the eastern United States, but it is not abundant.

Boletus retipes B. & C.

A common species in thin woods.

This species was first described from plants collected by Curtis in North Carolina. It has since been found quite commonly in the eastern United States, and as far west as Wisconsin. The cap varies from yellow to brown, the flesh and tubes are yellow, and the yellow stem is beautifully reticulated to the base.

Boletus scaber Fries.

Common in various habitats.

This is one of the best known and most abundant of all the species of boleti. The scabrous stem and the unchanging white flesh and tubes should distinguish it, in spite of the variable colors of the cap. Edible.

Boletus speciosus Frost.

Not rare in openings in woods.

This beautiful species is easily known by its apple-red cap without a bloom and its brilliant yellow tubes and stem, the latter reticulated. *B. bicolor* and *B. Peckii* are related species.

Boletus separans Peck.

A very abundant and very handsome species, found usually in open woods near the roads and trails. Also found in abundance at Falls Church, Virginia, during the latter part of July.

Cap and stem brownish lilac, the latter reticulated; flesh and tubes white; spores yellowish brown.

Boletus subtomentosus L.

Quite common along roads and trails.

This widespread plant has been reported from many parts of America. It is one of the boleti that may be dried in the sun, being of a spongy rather than a fleshy texture. The cap is usually yellowish brown or olive-tinted, with a distinct tomentum, and the large tubes and stem are yellow. *B. chrysenteron*, a closely related species, usually has more red both in cap and stem. Edible.

**Boletus Vanderbiltianus** sp. nov.

Pileus subconical, 2–3 cm. broad, 1–2 cm. thick; surface smooth, dry, conspicuously ornamented on the umbo with dense, pointed, imbricated, dark purple scales, which become gradually smaller and give place to minute purplish specks near the margin, the color changing from atropurpureous to latericeous; margin thin, undulate, concolorous, with a distinct inflexed sterile portion 1 mm. broad: context thick, fleshy, firm, cream-colored, unchangeable, sweet to the taste; tubes adnate, slightly decurrent on one side, salmon-colored near the margin, incarnate next to the stipe, unchangeable within, the mouths becoming incarnate as the spores mature, mouths angular, 1 mm. or less broad, elongated to 2 mm. near the stipe, edges thin, entire: spores oblong-ellipsoid, smooth, pale ochraceous-brown, 9–12 × 2–3 $\mu$: stipe curved, cylindrical, slightly enlarged above, delicately pruinose, not reticulated, deep salmon-colored, changing to incarnate, finely purplish-dotted like the margin of the cap, solid and cream-colored within, 2–3 × 0.5 cm.

A solitary specimen of this very beautiful little species was first found by the writer on the roadside in thin oak woods. Dr. House later collected several specimens of it and sent them to me. He reports it a slower grower, requiring three to five days to develop from the button stage, and its maximum height is rarely more than four centimeters.

FISTULINA HEPATICA Fr.

Common on chestnut stumps.

This well-known and widely distributed edible species is easily recognized by its resemblance to a piece of beefsteak. It is found almost exclusively, in this country, on chestnut and oak stumps.

FISTULINA PALLIDA Berk. & Rav.

Found only once on the base of a small decayed chestnut tree by the roadside.

This species probably occurs throughout most of the eastern United States, but it has been rarely collected. The cap is paler in color than that of *F. hepatica* and the stem is longer and more branched. These characters, with the white flesh, should easily distinguish it.

STROBILOMYCES STROBILACEUS (Scop.) Berk.

Abundant on shaded banks along roads and trails.

This species is blackish and shaggy, with white flesh, which on being cut or broken changes to reddish and finally to black. It is abundant everywhere in the woods, and is often collected for food.

## KEY TO THE ABOVE SPECIES*

**A.** Cap red, without and within, stem very short. *Fistulina hepatica*

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* See appended key to groups reprinted from TORREYA for March, 1908.

Cap fawn-colored without, white within, stem much longer and branched. *Fistulina pallida*

**B.** Tubes large, arranged in radiating rows; pileus and stem adorned with conspicuous red scales. *Boletinus pictus*

**C.** Pileus blackish and shaggy; flesh white, changing to reddish when bruised. *Strobilomyces strobilaceus*

**E.** Stem annulate and glandular-dotted. *Boletus luteus*

**F.** Pileus yellow, often streaked with bright red; stem slender, 8 mm. or less in diameter. *Boletus americanus*

Pileus brown when moist, yellowish on drying; stem stouter, over 8 mm. in diameter. *Boletus granulatus*

**G.** Stem shaggy and lacerate, with deep reticulated furrows; cap viscid and glabrous. *Boletus Morgani*

**H.** Flesh and tubes becoming deep blue when wounded. *Boletus cyanescens*

Flesh and tubes white or yellowish, unchanging when wounded. *Boletus castaneus*

**I.** Stem and pileus covered with a conspicuous yellow powder. *Boletus Ravenelii*

**J.** Pileus large, stem 1 cm. or more thick.

Flesh decidedly bitter. *Boletus felleus*

Flesh not bitter. *Boletus indecisus*

Pileus small, stem about 5 mm. thick. *Boletus gracilis*

**K.** Tubes yellow within, mouths reddish orange. *Boletus luridus*

**L.** Stem entirely white or grayish white. *Boletus scaber*

Stem conspicuously bright yellow near the base. *Boletus chromapes*

**M.** Pileus gray, tubes white. *Boletus griseus*

Pileus yellow or brown, tubes yellow. *Boletus retipes*

Pileus red.

Stem bright lemon-yellow throughout. *Boletus speciosus*

Stem red below, yellow above. *Boletus Peckii*

**N.** Tubes white, afterwards colored by the ochraceous brown spores. *Boletus fumosipes*

Tubes salmon colored, spores yellowish brown. *Boletus Vanderbiltianus*

Tubes yellow or greenish yellow.

Tubes changing to blue when wounded.

Pileus subtomentose. *Boletus chrysenteron*

Pileus glabrous.

Pileus bright red to olivaceous, the entire plant quickly turning blue at any point where touched. *Boletus miniato-olivaceus*

Pileus dark red, not sensitive, changing color slowly or not at all when bruised. *Boletus bicolor*

Tubes not changing to blue when wounded.

Pileus subtomentose, tubes becoming greenish yellow. *Boletus subtomentosus*

Pileus glabrous, tubes remaining a beautiful golden yellow even after long drying. *Boletus auriporus*

**O.** Stem and pileus bright golden yellow; plant small. *Boletus auriflammeus*

Stem brownish lilac or chocolate-brown.

Stem reticulated. *Boletus separans*

Stem furfuraceous, not reticulated. *Boletus eximius*

## Groups of North American Boleti

- Tubes separated from each other; stem lateral; plants found on decaying stumps, trunks or roots. **A**
- Tubes attached to each other; stem central, rarely eccentric; plants terrestrial, except in very rare instances.
  - Tubes arranged in radiating rows. **B**
  - Tubes usually small, not arranged in radiating rows.
    - Pileus conspicuously floccose.
      - Spores blackish brown. **C**
      - Spores ferruginous. (*Boletus Ananas.*) **D**
    - Pileus glabrous or subtomentose.
      - Stem annulate. **E**
      - Stem exannulate.
        - Stem and tubes glandular-dotted with a gummy secretion that hardens and turns black soon after exudation. **F**
        - Stem shaggy and lacerate, with deep reticulated furrows; spores olive-brown. **G**
        - Stem hollow at maturity; spores pale yellow, elliptical. **H**
        - Stem and pileus covered with a conspicuous sulphur-yellow powder. **I**
        - Not as above.
          - Spores flesh-colored; tubes adnate, whitish, tinted by the spores at maturity. **J**
          - Spores not flesh-colored, usually yellowish brown.
            - Tubes with red or reddish brown mouths, yellowish within. **K**
            - Tubes not as above.
              - Tubes free, white, not stuffed when young; stem not reticulated, often scabrous. **L**
              - Tubes adnate, white or yellow, not stuffed when young.
                - Stem reticulated. **M**
                - Stem not reticulated. **N**
              - Not as above. **O**

New York Botanical Garden.

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# NOTES ON PHILOTRIA RAF.

BY PER AXEL RYDBERG

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[From the BULLETIN OF THE TORREY BOTANICAL CLUB 35: 457-465. 1908]

# Notes on Philotria Raf.

PER AXEL RYDBERG

When trying to determine the Rocky Mountain specimens of *Philotria*, I happened to run across Caspary's very interesting paper on "Die Hydrilleen" in the Jahrbücher für wissenschaftliche Botanik.* It is rather surprising that very little has been written in this country on this American genus, when Caspary devotes over 50 pages to this genus and 137 pages to the tribe *Hydrilleae*. The genus needs, however, a good deal of more critical study in the field and these notes are written to call attention to this very interesting genus of water plants. I shall here give a short recapitulation of its history.

The genus was first described in Michaux's Flora Boreali-Americana † under the name *Elodea*, which, however, is antedated by *Elodes* Adans. Here the genus is characterized as having hermaphrodite flowers with three stamens, thick filaments, cordate anthers, and three bifid styles. The leaves in *E. canadensis* Michx. are described as being oblong and obtuse.

Muhlenberg ‡ referred the plant to the Old World *Serpicula verticillata*, described the staminate flowers as 4-merous, and added a variety *angustifolia* with narrow leaves.

The next description we find in Pursh's Flora Americae Septentrionalis § as *Serpicula occidentalis*. The description here agrees with that in Michaux's Flora, except that the leaves are described as linear, acute, and finely serrulate.

Rafinesque || gave no description, but merely changed Michaux's *Elodea* to *Philotria* on account of the earlier *Elodes* of Adanson.

Nuttall ¶ proposed a new genus *Udora* and cited *Elodea*

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* 1 : 377-513. 1858.

† 1 : 20. 1803.

‡ Cat. Pl. Am. Sept. 84. 1813.

§ 1 : 23 and 33. 1814.

|| Am. Monthly Mag. 2 : 175. 1818.

¶ Gen. N. Am. Pl. 2 : 242. 1818.

Michx. as a synonym but described the plant as dioecious, the staminate flowers with nine stamens in two series, the inner of which has three stamens, and the pistillate flowers with three sterile filaments and three ligulate bifid stigmas. He added further: "flowers very small and evanescent, the female emerging; the male migratory, breaking off connection usually with the parent plant, it instantly expands to the light, the anthers also burst with elasticity and the granular pollen vaguely floats upon the surface of the water." He described the leaves as oblong-linear, minutely serrulate, and partly obtuse.

Torrey * described *Udora* as being polygamous. "STERILE FL[OWERS]. Stamens 9: anthers oval, nearly sessile. PERFECT FL[OWERS]. Tube of the perianth produced above the ovary into a very long slender tube. Stamens 3–6: filaments short, subulate: anthers oblong, innate; the cells parallel, distinct . . . stigmas 3, large, spreading, oblong-cuneiform, 2-lobed." He described the leaves as varying from oblong-ovate to lanceolate-linear.

How are these conflicting descriptions to be reconciled? Have some of the authors mentioned been mistaken? Are there more than one species confused or is *Philotria canadensis* (Michx.) Britton such a variable plant both as to flowers and leaves? If more than one species, are they all polygamo-dioecious with three kinds of flowers: staminate with very short calyx-tube and 9 stamens; pistillate with long tube and no stamens or merely rudimentary filaments; and hermaphrodite flowers with long tube and 3–6 stamens? These are questions to be answered and botanists who have a chance to study the plants in the field will be well paid in investigating these interesting water-weeds. The writer would also be very thankful for material.

Let us see what is the present knowledge of the genus. Let us take up the different species proposed and the different descriptions, in the order they appear.

ELODEA CANADENSIS Michx. Fl. Bor.-Am. 1: 20. 1803.

This was described as having hermaphrodite flowers with 3 stamens and bifid stigmas, and oblong, obtuse leaves. Is there such a plant? Caspary, who saw the original Michauxian material at Paris, stated that the two flowers found there were hermaphrodite as described. He stated also that he had examined eight specimens collected by Moser in Pennsylvania, in 1832, and one by Schweinitz. These were all hermaphrodite, with from 2 to 7 stamens. In the Torrey herbarium there is a specimen of Moser's collection, but the tops of the flowers are broken off. In this specimen, however, the leaves are not oblong and obtuse, as described by Michaux, but linear and acute. There are other specimens in our herbaria with oblong or oblong-ovate leaves. One of these represents *Udora canadensis* of Torrey's Flora of New York from Torrey's sets distributed in connection with that publication. The flowers are hermaphrodite, as Torrey described his fertile flowers. Torrey stated that he had not seen any living sterile flowers but drew his description of them from material collected by Engelmann. This material I shall discuss later. There are other broad-leaved specimens, viz.: from Watertown, N. Y., 1834, *Dr. Gray;* East Haven Pond, Conn. (collector not given); Thousand Islands, N. Y., July 16, 1889, *John Northrop;* Prior's Lake, Minn., 1891, *C. A. Ballard;* Fish Creek, Sylvan Beach, N. Y., *L. M. Underwood 3211;* Waynesborough, Va., 1897, *W. A. Murrill;* Chilson Lake, N. Y., 1900, *Dr. & Mrs. N. L. Britton;* but all these have no flowers or the flowers are in such condition that it is impossible to say whether they are pistillate or hermaphrodite. None of these specimens has any sessile staminate flowers. Then the question arises: is the broad-leaved, *i. e.*, the typical *Philotria canadensis* (Michx.) Britton always hermaphrodite? Nobody, so far as I can find, has described any staminate flowers in connection with broad, oblong leaves.

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* Fl. N. Y. 2: 264. 1843.

SERPICULA VERTICILLATA Muhl. Cat. Pl. Am. Sept. 84. 1813.

This is described as monoecious and 3-androus, but the statement that the sepals and petals of the staminate flowers are four must have been an error or else Muhlenberg's specimens were abnormal. What it really was is of little consequence, as it is not *Serpicula verticillata* L.

SERPICULA VERTICILLATA ANGUSTIFOLIA Muhl. Cat. Pl. Am. Sept. 84. 1813.

This is of interest as it is the first name as far as known applicable to a form evidently distinct from *Elodea canadensis* Michx.

As far as I know, it is dioecious. The leaves are narrowly linear, acute, usually over 1 cm. long and about 1 mm. wide. The spathe of the staminate plant is 2–3 mm. long, subsessile, ovoid; the sepals and petals are elliptic, 2 mm. long; stamens 9; anthers oblong, about 1 mm. long. Spathe of pistillate plant linear-tubular, about 1 cm. long; tube of the flower 3–8 cm. long; sepals oblong, fully 1.5 mm. long; stamens none (only rudimentary filaments); stigmas 3, linear (whether 2-cleft or not cannot be determined). The name *Philotria angustifolia* was given to it in the Torrey herbarium. This name was taken up by me in my Flora of Colorado, but there applied to another species. It is represented by the following specimens: west side of 3d Ave., New York City, 1851, *Dr. Torrey & Dr. Gilman* [later than the publication of Torrey's Flora of New York], staminate and pistillate flowers; pool along Hudson River, below Hastings, 1895, *E. P. Bicknell*, pistillate flowers; brook from Fairy Dell, near Quogue, Long Island, 1885, *E. G. Knight*, pistillate flowers; Harrisburg, Pa., 1895, *J. K. Small*, sterile; Baltimore Co., Md., 1890, *K. A. Taylor*, pistillate flower (?), but only tube left; McCall's Ferry, Pa., 1893, *J. K. Small*, sterile. To this may also be counted the specimen of Moser mentioned above in the Torrey herbarium, which has however somewhat broader leaves. If this had hermaphrodite flowers, like the specimens seen by Caspary, this species may have all three kinds of flowers.

SERPICULA OCCIDENTALIS Pursh, Fl. Am. Sept. **1**: 33. 1814.

This agrees with *Elodea canadensis* Michx. in description, except that the leaves are described as linear and acute. There is, however, no specimen with hermaphrodite flowers and linear leaves in our collections, unless that of Moser had such.

UDORA CANADENSIS Nutt. Gen. N. Am. Pl. **2**: 242. 1818.

This is described as being dioecious, having staminate flowers with 9 stamens, pistillate ones with 3 sterile filaments and 3 ligulate, bifid stigmas, and oblong-linear, partly obtuse leaves.

This description fits a form somewhat similiar to the plants referred to *Elodea canadensis* Michx., but with more narrowly oblong, often somewhat acutish leaves. It is represented by the following specimens: Clifton, Passaic Co., N. J. 1891, *Geo. V.*

*Nash*, staminate and pistillate flowers; Buffalo, N. Y., *G. W. Clinton*, pistillate; Kendall, Orleans Co., N. Y., 1878, *H. S. Burnett;* Lake View, Jefferson Co., 1891, *Underwood*, pistillate; Fish Creek, Oneida Lake, N. Y., 1890, *Underwood*, pistillate; Wallace Switch, Va., 1892, *J. K. Small*, sterile. Nash's specimens are the only ones that have staminate flowers. The spathe is like that of *P. angustifolia*, but larger, 5–6 mm. long, the anthers in the unopened flower 2–2.5 mm. long. The *Udora canadensis* Nutt. may represent the unisexal form of *Elodea canadensis* but all these unisexual plants have narrower leaves than the specimens referred to the latter. It may represent a distinct species; if so, its name would be **Philotria Nuttallii**, as *Anacharis Nuttallii* Planch. was mostly based on this form.

ANACHARIS ALSINASTRUM Babingt. Ann. & Mag. Nat. Hist. II. **1**: 85. 1848.

This was described from specimens collected at Foxton Locks, near Market-Harborough, Leicester, England. The plant was at first looked upon as indigenous, but is now generally regarded as introduced. Babington's specimens, like all those collected in Europe, have only pistillate flowers; staminate and hermaphrodite ones are wholly unknown. The flowers have three oblong sepals and petals, three sterile filaments and club-shaped entire or merely emarginate stigmas, and oblong, obtusish leaves, sometimes as broad as those of *Elodea canadensis* Michx., sometimes hardly broader than those of *Udora canadensis* Nutt. or *Anacharis Nuttallii* Planchon, but always obtuse. This may be the pistillate form of *Elodea canadensis*, if this is polygamo-dioecious. The specimens in our herbaria are all European: canal near Hasselt, Villefranche, Rhône, France, 1874, *A. Méhu;* Lago di Manlova, Maggio, Italy, 1895, *De-Toni;* Gõta Elf, Sweden, 1899, *C. G. H. Thedenius;* Ostende, Belgium, 1871, *E. Cosson;* Spree, Berlin, Germany, 1877, *Mueller & Retzdorff;* Leigh Park, Hampshire, England, 1850. I collected it myself in the 1870's at Skara, Sweden.

ANACHARIS NUTTALLII Planch. Ann. Sci. Nat. Bot. III. **11**: 74. 1849.

This is based on *Udora canadensis* Nutt. Planchon distinguished it from *A. Alsinastrum* by the oblong-linear, not oval-oblong leaves, and the bifid, instead of emarginate, stigmas. Caspary includes herein also the specimens collected at St. Louis, Mo., and distributed as *Udora verticillata? minor* Engelm., but this I believe to be distinct. See below.

ANACHARIS CANADENSIS Planch. Ann. Sci. Nat. Bot. III. **11**: 75. 1849.

Planchon's description differs considerably from that of Michaux and he could not have had the same plant in mind. The plant is said to be dioecious, the spathe of the staminate flowers ventricose-obovate and short-peduncled, and the staminate flowers themselves apetalous. It was described from staminate specimens collected by Drummond in Saskatchewan and imperfect pistillate specimens from Canada collected by Cleghorn. There is no evidence that the two belonged to the same species, but the staminate plants of Drummond must be regarded as the type. On these was based

ELODEA PLANCHONII Casp., Jahrb. Wiss. Bot. **1**: 468. 1858.

This is evidently a very distinct species and unique in the two characters given. The staminate flowers are much larger than in the other North American species, but the pistillate ones are as small as those of *Philotria minor* Small (*Udora verticillata minor* Engelm.). The leaves are usually as narrow as in that species, and in *Philotria angustifolia* (Muhl.) Britton. In my Flora of Colorado I referred the specimens of that state to those species. Having discovered my mistake, I shall here give a fuller description of the plant:

### **Philotria Planchonii** (Casp.) Rydb.

Dioecious water-plant; stem slender, 1–5 cm. long; leaves in 3's or the lower opposite, 7–15 mm. long, oblong to lance-linear, acutish; spathe of the staminate flowers obovoid-clavate, nearly 1 cm. long, on a peduncle 5–10 mm. long; flowers short-pediceled; sepals elliptic, 5 mm. long; petals lacking; stamens 9, anthers oblong, 3–4 mm. long, subsessile; spathe of the pistillate plant linear or lance-linear, sessile, 2-cleft at the apex; calyx-tube slender, 3–5 cm. long; sepals and petals linear, about 3 mm. long; styles 3, linear; stamens none.

The following specimens belong here: Seven Mile Lakes, Albany County, Wyo., 1901, *Leslie N. Gooding 597*, staminate; Fish

Hatchery, Wyo., 1898, *Aven Nelson 5374*, pistillate; Lee's Lake, Colo., 1897, *C. S. Crandall 2423*, staminate; 1896, *2421*, fruit; Rio Grande, Alamosa, Colo., 1896, *C. L. Shear 3746*, staminate and pistillate; Wadsworth, Nev., 1887, *Tracy & Evans 475*, pistillate.

APALANTHE SCHWEINITZII Planch. Ann. Sci. Nat. Bot. III. **11**: 76. 1849.

Planchon distinguishes the genus *Apalanthe* from *Anacharis* by the hermaphrodite instead of dioecious flowers. Of how little value these characters are as generic distinctions may easily be settled by field work. From the description, this must be identical with *Serpicula occidentalis* Pursh. Of course, it is also *Elodea Schweinitzii* Casp. Jahrb. Wiss. Bot. **1**: 468. 1858.

ELODEA LATIFOLIA Casp.; Jahrb. Wiss. Bot. **1**: 467. 1858.

This was described from sterile material collected by Schweinitz. It was characterized by broad ovate-oblong leaves and rounded toothed stipules. Why is this not the typical *Elodea canadensis* Michx.?

UDORA VERTICILLATA ? MINOR Engelm.; under *Anacharis Nuttallii* Casp. Jahrb. Wiss. Bot. **1**: 465. 1858.

As stated before, Caspary included in *Anacharis Nuttallii* the specimens collected by Engelmann near St. Louis, Mo., and he cited Engelmann for the main part of the description of the flowers. I think, however, that Engelmann's plant is distinct from both the plant described by Nuttall and the plant collected by Torrey in New Jersey, which is the only one cited by Planchon. It is closely related to *Philotria angustifolia* (Muhl.) Britton, differing mostly in the size of the plant and the flowers. The spathe of the staminate plant is subglobose, 2 mm. long; sepals ovate; petals narrowly ovate, 1.5 mm. long; stamens 9, anthers scarcely 1 mm. long; spathe of the pistillate plant linear-tubular, 1 cm. long, 0.5 mm. thick; tube of the flower very slender, 3–6 cm. long; sepals and petals ovate, 1–1.5 mm. long; stigmas 3, club-shaped, bifid; leaves linear, acute, 5–8 mm. long, 1 mm. wide. This species is represented by the following specimens: St. Louis, Mo., 1845, *Engelmann*, pistillate and staminate plants, 3 sheets; Banks of Mississippi, Oquawka, Ill., *H. N. Patterson*, pistillate; Lexington, Ky., *Robert Peters*, pistillate; Linn County, Kansas, 1897, *G. L. Clothier*, sterile; Fox Lake, Wayne Co., Ohio, 1899, *Selby & Duvel 1321*, sterile; Milwaukee, Wis., 1887, *H. E. Hasse*, pistillate, long-leaved. The form has been raised to specific rank under the name

PHILOTRIA MINOR (Engelm.) Small, Fl. SE. U. S. 47. 1903.

Besides these, there seems to be another undescribed species:

### **Philotria linearis** sp. nov.

Apparently dioecious, stem slender, 3–5 dm. long; leaves linear, acute, about 1 cm. long, scarcely 1 mm. wide, entire; spathe of the staminate plant peduncled; peduncle 3–4 mm. long; body ovate, about 3 mm. long; sepals broadly oval, 2.5 mm. long; petals oblong; stamens 9, anthers oblong, 2 mm. long.

The type was collected in swamps bordering on Cumberland River, vicinity of Nashville, Tenn., by Dr. A. Gattinger. The pistillate plant is unknown unless a specimen collected at Center City, Minn., in 1892, by B. C. Taylor, belongs here. It resembles the pistillate plant of *P. minor*, but the leaves are longer and more flaccid; the tube of the flower is 4–6 cm. long; the sepals and petals more oblong.

*P. linearis* resembles *P. Planchonii* in having stalked staminate spathe, but differs in that the spathe itself is much smaller and abruptly contracted at the base, the sepals are of about half the size of those of that species, and petals are present.

With the material on hand it is almost impossible to determine how many species are found in this country and their limitation. From the present knowledge I would think the number to be at least six. Of these I append here a temporary key, wishing to call the attention of the botanists of this country to the confusion existing and to give a tentative basis on which to build further study.

Leaves oblong or ovate-oblong, mostly obtuse; staminate flowers unknown. *P. canadensis.*

Leaves linear or oblong, mostly acute; hermaphrodite flowers unknown.
  Staminate spathe sessile.
    Leaves oblong or lance-oblong, 2–3 mm. wide, spathe of staminate flowers 5–6 mm. long; anthers 2–2.5 mm. long. *P. Nuttallii.*
    Leaves linear, 1 mm. wide or less; staminate spathe 2–3 mm. long; anthers about 1 mm. long.
      Leaves 1 cm. long or more; sepals and petals 1.5–2 mm. long. *P. angustifolia.*

Leaves 5–8 mm. long; sepals and petals 1–1.5 mm. long. *P. minor.*

Staminate spathe peduncled.

Staminate spathe ovoid, abruptly contracted at the base; sepals 2.5 mm. long; petals present. *P. linearis.*

Staminate spathe obovoid, tapering at the base; sepals of the staminate flowers 5 mm. long; petals lacking. *P. Planchonii.*

The synonymy would be as follows:

PHILOTRIA CANADENSIS (Michx.) Britton, Science II. **2**: 5. 1895.

*Elodea canadensis* Michx. Fl. Bor.-Am. **1**: 20. 1803.

*? Anacharis Alsinastrum* Babingt. Ann. & Mag. Nat. Hist. II. **1**: 85. 1848.

*Elodea latifolia* Casp. Jahrb. Wiss. Bot. **1**: 467. 1858.

PHILOTRIA NUTTALLII (Planch.) Rydb. [See above.]

*Serpicula verticillata* Muhl. Cat. Pl. Am. Sept. 84. 1813. Not *S. verticillata* L. f. 1781.

*Udora canadensis* Nutt. Gen. N. Am. Pl. **2**: 242. 1818.

*Anacharis Nuttallii* Planch. Ann. Sci. Nat. Bot. III. **11**: 74. 1849.

PHILOTRIA ANGUSTIFOLIA (Muhl.) Britton; Rydb. Bull. Agr. Exp. Sta. Colo. **100**: 15. 1906.

*Serpicula verticillata angustifolia* Muhl. Cat. Pl. Am. Sept. 84. 1813.

*? Serpicula occidentalis* Pursh, Fl. Am. Sept. **1**: 33. 1814.

*? Serpicula canadensis* Eat. Man. 391. 1829. [Ed. 5.]

*? Apalanthe Schweinitzii* Planch. Ann. Sci. Nat. Bot. III. **11**: 76. 1849.

? *Elodea Schweinitzii* Casp. Jahrb. Wiss. Bot. **1**: 468. 1858.

PHILOTRIA MINOR (Engelm.) Small. Fl. SE. U. S. 47. 1903.

*Udora verticillata* ? *minor* Engelm.; Casp. (synonym under *Anacharis Nuttallii*) Jahrb. Wiss. Bot. **1**: 465. 1858.

PHILOTRIA LINEARIS Rydb. [See above.]

PHILOTRIA PLANCHONII (Casp.) Rydb. [See above.]

*Anacharis canadensis* Planch. Ann. Sci. Nat. Bot. III. **11**: 75. 1849.

*Elodea Planchonii* Casp. Jahrb. Wiss. Bot. **1**: 468. 1858.

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# SOME NOTES ON THE CHEMICAL COMPOSITION AND TOXICITY OF IBERVILLEA SONORÆ

By JULIA T. EMERSON and WILLIAM H. WELKER

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# SOME NOTES ON THE CHEMICAL COMPOSITION AND TOXICITY OF IBERVILLEA SONORAE.

(Plates IV and V)

By JULIA T. EMERSON and WILLIAM H. WELKER.[1]

(*From the Laboratories of the New York Botanical Garden and the Laboratory of Biological Chemistry of Columbia University, at the College of Physicians and Surgeons, New York.*)

(Received for publication, September 2, 1908.)

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## I. INTRODUCTION.

Among the many plants about which we know little or nothing chemically is *Ibervillea Sonoræ*. Some of the largest tubers of this species were collected by Dr. D. T. MacDougal in Sonora, N. M., in 1902. At the suggestion of Dr. MacDougal, and under the direction and with the assistance of Dr. William J. Gies, this study of the stem[2] ("root") was undertaken. An effort was made to ascertain its general chemical composition. We also endeavored to determine the nature of the substance or substances in it which account for the poisonous qualities attributed to it by the inhabitants of the regions in which it is found.

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[1] The work on chemical composition was done by Miss Emerson at the New York Botanical Garden. The experiments on the toxicity of the root were carried out by Mr. Welker in the Laboratory of Biological Chemistry of Columbia University, at the College of Physicians and Surgeons, New York.

[2] Knox: *Bulletin of the Torrey Botanical Club*, xxxiv, p. 329, 1907. See the second footnote on p. 341

## II. HISTORICAL.

(1) A genus under the name of *Sicydium* was described by Schlechtendal in 1832 (*Linnæa*, vii, p. 388), based upon *Sicydium Schiedeanum*, a Mexican plant.

(2) Gray described in 1850 *Sicydium Lindheimeri* (*Bost. Jour. Nat. Hist.*, vi, p. 194) from Texas.

(3) *Sicydium Lindheimeri* was made the type of a new genus, *Maximowiczia*, by Cogniaux, in 1881 (*D. C. Monog. Phan.*, iii, p. 726).

(4) *Maximowiczia Sonoræ* was described by Sereno Watson in 1889 (*Proc. Amer. Acad. Arts and Sci.*, xxiv, p. 51).

(5) As the name Maximowiczia had been used before 1881 for another genus (by Ruprecht in 1859, for a genus of Magnoliaceæ), Greene (*Erythea*, iii, p. 75, 1895) substituted for the cucurbitaceous genus the name *Ibervillea*, and *Maximowiczia Sonoræ* thus became *Ibervillea Sonoræ*.

## III. GENERAL DESCRIPTION OF THE SPECIES SONORÆ.

*Ibervillea* belongs to the Cucurbitaceæ or Gourd family, and has been found in Mexico, New Mexico, Texas, and California. As Watson's (4) is the only full description of the species Sonoræ, it is quoted below.

> Climbing, glabrous throughout, the large root (stem) projecting above ground; leaves four inches broad or less, twice three-cleft nearly to base, with broad sinuses, the lobes coarsely sinuate-toothed; male flowers racemose, short-pedicellate, the calyx-tube cylindrical, 3 lines long; petals pubescent, villous within, bifid; fertile flowers on peduncles 2 to 3 lines long; ovary ovate, long-attenuate above; fruit ovate, abruptly stout beaked, amber colored 1¼ to 1½ inch long, smooth with a thick fleshy rind; placentæ many (about 14) seeded; seeds covered with a red pulp, compressed, rough coated excepting the smooth margin, obovate or oblong-obovate with a broad base, 3 lines long or more.
>
> This species much resembles *M. Lindheimeri*, but the leaves are more dissected and the ovary and fruit more attenuate above, and the seeds though decidedly turgid in the young fruit, become compressed and are peculiar in their generally very rugose-tuberculate surface. The green fruit is described as having about ten longitudinal rows of white dots.

The upper side of the swollen underground portion where it is exposed to the light is of a green-gray color owing to chlorophyll just beneath the periderm, while the upper side is thicker, brown and without the green. The substance of the "root" is much the same throughout; firm, fibrous near the stem or a bud, more difficult to cut and tougher than a potato, and of a light yellow color. Its general shape is round, like a gourd, with a neck leading up to the shoots and several thick roots extending downwards, and it may become as large as two feet in diameter and weigh many pounds. There is a characteristic odor somewhat like that of an earthy potato, and after working with fresh material some time the nose and throat feel dry and irritated, while a bitter tasting substance remains on the fingers, even after several washings.

Figs. A and B show the organographic characters of the species, both at the adult stage in its native habitat, and as a seedling from four to five years old. The large projecting root of *Ibervillea* in the specimens in the greenhouses of the Botanical Garden reaches a diameter of from 25 to 30 cm. In the desert this enormous tuberous growth lying in the dry sand looks like a gray, dust-covered boulder. Frequently irregularities of shape give it still more the effect of stone, and it is only when the cortex is flecked off that one discovers the healthy green color beneath the superficial layer. From the tubers arise yearly long flexible liana-like shoots which reach a length of three or more meters. The shoots are round, smooth and green above, brown-gray and gray-spotted or streaked below. The flowers are dioecious, the tendrils branched, and the leaves bright-green and twice three-cleft as is so frequently the case throughout the family. The fruit is said to be "amber colored" and 1¼ to 1½ inch long; none has ripened in the greenhouse, as the flowers there are staminate only. The plant is able to persist in its arid habitat with remarkable vitality. In fact, so provident is it of water and nutritive substances that one in the museum case at the Garden which has been lying on a board since 1902 is, in 1908, still sending up yearly shoots bearing leaves and tendrils. Every fall the shoots die back and sprout again early the next spring.[1]

### IV. GENERAL QUANTITATIVE COMPOSITION.

Water, solids, organic and inorganic matter in the stem were determined by the usual methods. After removal of the bark, fresh portions of the stem[2] were quickly cut into small pieces and weighed in porcelain crucibles as rapidly as possible. Each sample was dried to constant weight in an air bath at 100° C., in which process all water was removed. The weight of the dry solid matter was taken and, after complete incineration at a low temperature, the weight of the ash was also noted. The following weights and percentages were recorded in this connection:

---

[1] Knox: *Loc. cit.* This paper gives the results of a thorough anatomical study of the stem ("root") of *Ibervillea Sonoræ.*

[2] This tuber is ordinarily referred to as a root * * * The picture of the old plant (Fig. A) with its shoots rising from the tuber, shows the gradual enlargement of the stem, though the appearance of the seedling

RECORDED ANALYTIC DATA.

| Tuber Sample. | Fresh substance. grams. | Dry substance. grams. | Ash. gram. |
|---|---|---|---|
| 1 | 12.0060 | 1.6690 | 0.1710 |
| 2 | 15.4403 | 1.9223 | 0.2203 |
| 3 | 19.3512 | 2.3222 | 0.3822 |
| 4 | 14.9534 | 1.9834 | 0.2144 |
| Average | 15.4377 | 1.9742 | 0.2219 |

GENERAL PERCENTAGE COMPOSITION.

| Tuber Sample. | Water. | Solids. | Organic matter. | Inorganic matter. |
|---|---|---|---|---|
| 1 | 86.10 | 13.90 | 12.49 | 1.41 |
| 2 | 87.56 | 12.44 | 11.02 | 1.42 |
| 3 | 88.00 | 12.00 | 10.60 | 1.40 |
| 4 | 86.74 | 13.26 | 11.82 | 1.44 |
| Average | 87.10 | 12.90 | 11.48 | 1.42 |

## V. GENERAL QUALITATIVE COMPOSITION.

In an endeavor to ascertain the character of the more conspicuous constituents of the tuber, grouped under the general term "solids," various extracts were made and tested. Between the arrival of the tubers from Sonora and the time when they were used for this study (almost a year), they remained in the laboratory on saucers, without earth or water, and seemed to keep perfectly, one even putting out several shoots during the summer.[1]

*Preparation of material.* In the preparation of the tuber for these tests, dirt and dust were brushed off and the tuber was

---

(Fig. B) would indicate that the swollen portion includes root, hypocotyl and stem. * * * The formation is stem and at least half of the swollen portion may claim that distinction.—Knox, *loc. cit.*, p. 340.

[1] The quantitative data recorded above were obtained from tubers in the same general condition.

washed. Sometimes the bark was removed; at other times the entire root, after removal of injured or abnormal portions, was finely divided in a meat chopper. Portions of the chopped tuber were at once put in bottles with one of the solvents named below, a few drops of toluol or chloroform being added as preservatives. After standing generally a week, the extract was filtered and this filtrate used in the experiments.

Extracts were made with the following solvents: Water, 95 per cent alcohol, ether, glycerol, 10 per cent sodium chlorid, or acidified water (very dilute hydrochloric acid). The aqueous and saline extracts were slightly acid in reaction (litmus).

The common qualitative reactions on these extracts made it evident that the root contains representatives of the following groups of substances: proteins, carbohydrates, fats, cholesterins, lecithins, basic substances, salts of organic acids, and inorganic salts.

*Proteins.* The simple proteins present in the tuber were of the coagulable type only. Proteose and peptone could not be detected in any of the extracts after removal of the coagulable proteins. Nucleoprotein was present in small proportions in the extracts and could be precipitated by acid. On decomposition in hot acid the protein yielded purin bases, simple protein and phosphate.

It was hoped by finding the temperature at which coagulations resulted in the extracts, to gain some idea of the number and types of the coagulable proteins present. The results were not very definite, however. Ten per cent salt extract, for example, showed turbidity at the low point of 25° C. The temperature was gradually raised and at 61° C. a fine flocculent precipitate appeared. On filtering, a clear yellow filtrate was obtained. On reheating, initial turbidity became apparent above the temperature of former turbidity but below that of former flocculation; in this way six to eight flocculations were obtained at temperatures ranging between 25° C. and 80° C.

On adding to an aqueous or saline extract an equal volume of saturated ammonium sulfate solution, a fairly bulky precipitate of "globulin" was obtained. The half saturated filtrate gave an abundant yield of albumin when ammonium sulfate was added to complete saturation. Saturation of the saline extract with magnesium sulfate precipitated globulin. Solutions of both the globulin and the albumin precipitates obtained in this way gave no more satisfactory differential results with the coagulation method than the original extracts. The number of globulins and albumins present was not, therefore, ascertained. It appeared probable that these proteins coagulated through ranges of degrees of temperature that overlapped each other, so to speak, thus making differentiation by this process impossible, or else that other substances were precipitated in such ways as to interfere in the manner indicated.

The precipitates obtained at some of the lower temperatures may have consisted largely of earthy phosphate, for they were not appreciably soluble in 10 per cent sodium chlorid solution or in 0.5 per cent sodium carbonate solution, but readily dissolved in 0.2 per cent hydrochloric acid.

The precipitates obtained at the higher temperatures, on the other hand, were true coagula, for they were practically insoluble in all of the three reagents named.

*Carbohydrates.* The carbohydrates present in the tuber were chiefly woody fiber and small amounts of reducing sugar and starch. The nature of the small amount of sugar was not determined.

*Fat, cholesterin* and *lecithin* were extracted and separated by Zuelzer's ether-acetone method.[1] No attempt was made to ascertain the characters of either the fatty matter or the lecithin. Their quantities appeared to be relatively slight.

*Saline matters*, especially chlorid, sulfate and phosphate, sodium, potassium, calcium, magnesium and iron could be readily detected. The ash contained carbonate, most of which was formed by the combustion of the organic matter. Salts of organic acids were frequently indicated, in the various reactions tried, but no attempt was made to ascertain the characters of the organic radicals. Tri-basic calcium phosphate was precipitated in relative abundance from aqueous and saline extracts on warming. Earthy phosphate was subsequently found to occur in the root, and in such extracts.

*Enzymes* were looked for but were not detected. Proteolytic, diastatic and oxidative enzymes appeared to be absent. It is possible that the conditions of the tests were not favorable to digestive results, although ordinary methods were used.

---

[1] Zuelzer: *Zeitschr. für physiol. Chem.*, xxvii, p. 255, 1899.

*Basic substances.* A few tests for alkaloids, with the so-called alkaloidal reagents, in extracts free from coagulable protein, gave indications of the presence of basic substances (see p. 346).

*Chlorophyll* was conspicuous in the subcortial tissue.

## VI. TOXICOLOGICAL NOTES.

In Mexico where *Ibervillea Sonoræ* grows in abundance, the natives consider it poisonous. Watson[1] has stated that "a decoction of the root is used as a cathartic."

*Preliminary toxicological experiments on frogs.* Several preliminary tests of the toxicity of the tuber were made on frogs, by injecting under the skin or into the stomachs small volumes of concentrated aqueous solutions of dry residues from alcohol or ether extracts, with the following results:

(*a*) Residue from *alcohol* extracts. First frog: Introduction *per os*. No visible effects. Second frog: Injection subcutaneously. Spasms occurred in a few minutes; later there was retching. Death ensued in three hours.

(*b*) Residue from *ether* extracts. Third frog: Introduction *per os*, about 3 p.m. There were signs of nausea during the afternoon. Death occurred during the night. Fourth frog: Injection subcutaneously. Convulsive movements preceded death in 2½ hours.

The results of these tests led us to look for alkaloids. For the preliminary isolation of any of the latter that might have been present in the tuber we proceeded as is indicated below:

*Tests for alkaloids.* The Stas-Otto method was employed for the preparation of the extracts to be tested. The interior portions of two tubers were finely minced and subjected to extraction separately. Two alcoholic extracts were made of each. The residues from each yellow alcoholic extract, which were obtained by evaporation *in vacuo* at 40° C., were treated with absolute alcohol, filtered and again evaporated to dryness. The residues from the absolute alcohol were treated with water, the filtered solutions rendered alkaline with sodium carbonate[1] and any alkaloids extracted with ether. Each residue was treated thrice with fresh ether. The ether extracts were allowed to evaporate to dryness spontaneously. The resultant dry residues, which were yellowish in color and very bitter, were used in the tests referred to below:[2]

---

[1] See p. 340.

*Chemical tests.* Samples of the various residues obtained by the above described method were dissolved in dilute hydrochloric acid or alcohol and tested with common reagents for alkaloids. White, amorphous precipitates were obtained with potassium hydroxid, phosphomolybdic acid, phosphotungstic acid and tannic acid.

Precipitates failed to form with solutions of picric acid, platinic chlorid, iodin in potassium iodid solution, bromin in hydrobromic acid solution, potassium sulphocyanid, potassium chromate, potassium dichromate, potassium iodid, mercuric chlorid, potassium ferrocyanid, potassium ferricyanid.[3]

The material in the extracts gave color reactions with the following reagents: Sulfuric acid, Erdmann's reagent, sulphovanadic acid, and Fröhde's reagent. None of these results was characteristic of any particular alkaloid, however, nor were mixtures of alkaloids suggested.

The reaction with sulfuric acid and potassium permanganate in its first stages resembled the coloration obtained with strychnin in the oxidation test, but it failed to exhibit the successive changes of coloration characteristic of the alkaloid in that reaction. The color was not given with any other oxidizing reagents in sulfuric acid. According to Wormley, this reaction, if potassium permanganate is employed as the oxidizing agent, is given by aqueous extracts of certain plants and even by shreds of filter paper.[1]

---

[1] The yellow color changed to orange.

[2] While we were removing residue from one of the evaporation dishes, an associate who was fully ten feet away and who knew nothing about the peculiar qualities of the residue, expressed surprise at a bitter taste he suddenly experienced. The very minute amount of dust that was formed as we carefully scraped the residue from the dish accounted for the experience referred to, which gives a good idea of the extreme bitterness of the material.

[3] Precipitates formed by reaction between the solvent and the reagent are here ignored.

*Physiological tests.* Toxicity of the residues obtained by the method described above was determined by dosing a 2.7 kilo female pup as follows:

Administration *per os: 1st day.* The dog was given in one meal daily an ordinary quantity of food consisting of meat, cracker meal, lard, bone-ash and water. The weight of the residue given the first day was 0.0523 gram. It was placed inside of a ball of meat and in this condition swallowed without mastication. Except very slight diarrhea during the following night, no effects were observed.

*2d day.* On the second day of the experiment 0.1046 gram of residue was administered in the food as before. Slight diarrhea, about nine hours after feeding, was the only apparent effect of the material.

*3d day.* On the third day the animal was apparently perfectly normal, and accordingly a study of the effects of *subcutaneous* injections of the material was begun on the following day.

Subcutaneous injection: *4th day.* The animal appeared to be normal in all respects. About 0.05 gm. of residue was dissolved in 3 to 4 cc. of alcohol, and injected on the right side. No general effects whatever were observed during the following twenty-four hours.

*5th day.* On this day about 0.1 gram of residue was injected in 3 to 4 cc. of alcoholic solution. No symptoms of any toxic action were observed during ten hours following the injection. A small abscess formed at the point of injection; otherwise the animal apparently remained normal during the next two days, when observation was discontinued.

These tests failed to show the presence in the extracted material of any known alkaloid or alkaloids. The physiological tests indicated further that, if any alkaloid was present, its proportionate content was too slight to enable it to exhibit distinct or characteristic effects.

*Tests of the effects of hashed tuber given by mouth to dogs.* The results of the foregoing toxicological tests suggested either that our extracts did not contain the toxic principle of the tuber or that the reputed poisonous action of the tuber is due to some compound other than an alkaloid. To decide this question, a number of special experiments on toxicity were conducted.

Two tubers were rapidly peeled, sectioned and hashed. The interior of one of them was found to be full of small brown masses. The other tuber was apparently normal in all respects. The mass of each tuber was kept separate on the assumption that possibly the abnormal specimen would show different toxic results from those of the normal tuber; also with the idea that perhaps the toxicity ascribed to *Ibervillea Sonoræ* in general was due to special poisonous principles in such abnormal tubers and that particular effort should be made to determine this possibility. The rinds were also hashed. Each product was bottled and placed in a cold room which was kept constantly at a temperature of about — 5° C.

---

[1] Wormley: *Micro-chemistry of Poisons*, 2d ed., p. 589, 1885; Sedgwick: *Amer. Chem. Journ.*, p. 369, 1879.

The following quotations from our records of this series of experiments will suffice to show the results obtained.

*Sixth experiment with normal tuber.* Weight of dog, 25.7 kilos.[1]

*1st day.* Sixteen grams of tuber were administered in balls of meat at 11 a.m. In the afternoon a feverish and restless condition was observed. This was very much less marked during the evening. Pronounced diarrhea occurred between midnight and 8 a.m. *2d day.* By 10 a.m. the condition of the dog was apparently very close to normal. Twenty-four grams of tuber were given in meat at 10.30 a.m. The feverish condition reappeared unmistakably at 1:45 p.m. Vomiting occurred at intervals between 5 and 9:45 p.m. No defecation occurred during the day, at the end of which the dog was apparently normal. *3d day.* Thirty-two grams of tuber were administered with the regular diet at 10:50 a.m. At 12:30 p.m. the animal became feverish and uncomfortable. Three hours later very marked diarrhea occurred. About 6 p.m. a considerable portion of the food given in the morning, including a fairly large proportion of meat, was vomited. Between 7 and 8 p.m. marked diarrhea occurred. From this time until the next morning, recovery was rapid. The dog was apparently normal at the end of that period. *4th day.* The dose of tuber was again increased and 40 grams were given with the usual diet between 11 a.m. and 1 p.m. At 1:40 p.m. the first signs of sickness appeared. Between 4:15 p.m. and 5:20 p.m. very marked diarrhea occurred. This was followed by rapid recovery and the dog was nearly normal four hours later. *5th day.* The animal refused to eat the meat balls containing the tuber and so was allowed to fast until the sixth day. *6th day.* The dog again refused the meat balls. They were given forcibly. He received 50 grams of tuber at noon. The feeding was followed by a five-hour period of feverishness and restlessness. This was succeeded by very marked diarrhea. By midnight the dog had practically recovered. He remained well. The same animal was used in the seventh experiment.

*Seventh experiment; with abnormal, i. e., "spotted" tuber, and with the rind.* About a month and a half after the completion of the preceding experiment, the dog of that experiment, which showed no subsequent ill effects of the treatment described above, was subjected to dosage with the abnormal tuber. Diet and method of dosage were the same as in the sixth experiment.

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[1] Daily diet—hashed meat, cracker meal, lard and water, with bone-ash. A preliminary period of five days established normal conditions.

A. *1st day.* Five grams of "*spotted*" *tuber* were given without effect. The feces passed this day were hard and dry. *2d day.* Ten grams of tuber were given. There were no apparent effects. *3d day.* Twenty grams of tuber were administered in gelatin capsules. This dose also failed to produce any toxic symptoms. The feces remained hard and dry. *4th day.* Forty grams of tuber were given in capsules as before. Apparently no effects were produced. *5th day.* Fifty grams of tuber were given at noon in capsules as before. Slight diarrhea occurred during the afternoon and evening, while marked diarrhea ensued between midnight and 8 a.m. The dog was apparently normal at 9 a.m. *6th day.* The regular diet was fed without the tuber.

B. *7th day.* Twenty-five grams of *rind* were given in gelatin capsules with the regular diet. Very marked diarrhea occurred about six hours later. The dog seemed normal on the following morning. *8th, 9th and 10th days.* The dog was fed the usual diet without any rind. *11th day.* Twenty-five grams of rind were given in capsules without producing any apparent effect. *12th day.* Twenty-five grams of rind were given. Three hours later marked diarrhea ensued. This was followed by the vomiting of undigested meat. *13th day.* The animal fasted. *14th day.* A small meal was fed in the afternoon. *15th day.* Twenty-five grams of rind were given in capsules with the regular diet at 10 a.m. Diarrhea occurred between 8 and 8:45 p.m. By the following morning the dog had apparently recovered.

These experiments and the remaining ones of the series made it evident that the toxicity and even the cathartic effects of *Ibervillea Sonoræ*, as measured by results on our dogs, have perhaps been overrated. In some instances, comparatively large quantities of the hashed tuber or the rind were entirely devoid of obvious effects. The "spotted" tuber was no more (but perhaps less) toxic than the normal tuber. These results were also in accord with our previous conclusion that there is little if any alkaloid present in the tuber.

Although the toxic and cathartic effects were relatively slight, it was thought that possibly oxalic acid was present in sufficient proportion to share in producing the effects noted. Analysis of a fresh portion of tuber made it evident, however, that the proportion of oxalic acid in the tuber was very slight.

It also seemed possible that magnesium salts might have participated in the cathartic effects observed. Partial quantitative analysis of the ash gave the following *percentage* results: CaO, 23.76; MgO, 15.62; $CO_2$, 13.92; Cl, 11.96; $P_2O_5$, 8.1. Sodium and potassium were present in abundant proportions. The proportion of ash in the fresh tuber was only about 1.4 per cent.

Although it did not seem probable that the observed cathartic action could be due solely to the small amounts of compounds of the alkali earth metals that were present, we tested the effects of the ash in some experiments of which the following, as described in our records, is an illustration.

*Tests of the effects of tuber ash given by mouth to dogs.* Tenth experiment. Weight of the dog, 7.22 kilos.[1] On the first day of the experiment the animal was given 0.6 gram of ash corresponding to the inorganic matter in about 45 grams of tuber. This was administered in several small balls of meat. No other food was given that day. There were no apparent effects. On the following day the fast was continued and an equal portion of ash, i. e., 0.6 gram (which had been largely converted into chlorid by treatment with hydrochloric acid, with subsequent removal of the acid by evaporation to dryness) was dissolved in distilled water and administered by means of a stomach tube. This also failed to produce any noticeable effects. The dog was apparently normal in all respects during the three succeeding days, after which he was no longer kept under observation.

The results of the experiments in this series also fail to explain the effects caused by the tuber. Unfortunately, our supply of tubers was exhausted at this point and further study had to be given up.

## VII. GENERAL CONCLUSIONS.

Besides yielding the data for composition of *Ibervillea Sonorœ*, our study indicates that the tuber does not contain alkaloidal material, or at least not in sufficient proportion to cause particular toxicity. We have not learned the reason for the cathartic effects exhibited by the tuber or its decoctions.

We wish to thank Dr. Gies for his kind guidance and advice in this study, and also for his assistance in carrying out the work.

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[1] Daily diet—hashed meat, cracker meal, lard and water, with macerated filter paper to make the feces bulky and approximately normal in consistence. For this purpose bone ash was avoided in order to give the tuber ash full opportunity to display its greatest possible toxicity, without unnecessary interference. A preliminary period of five days established normal conditions.

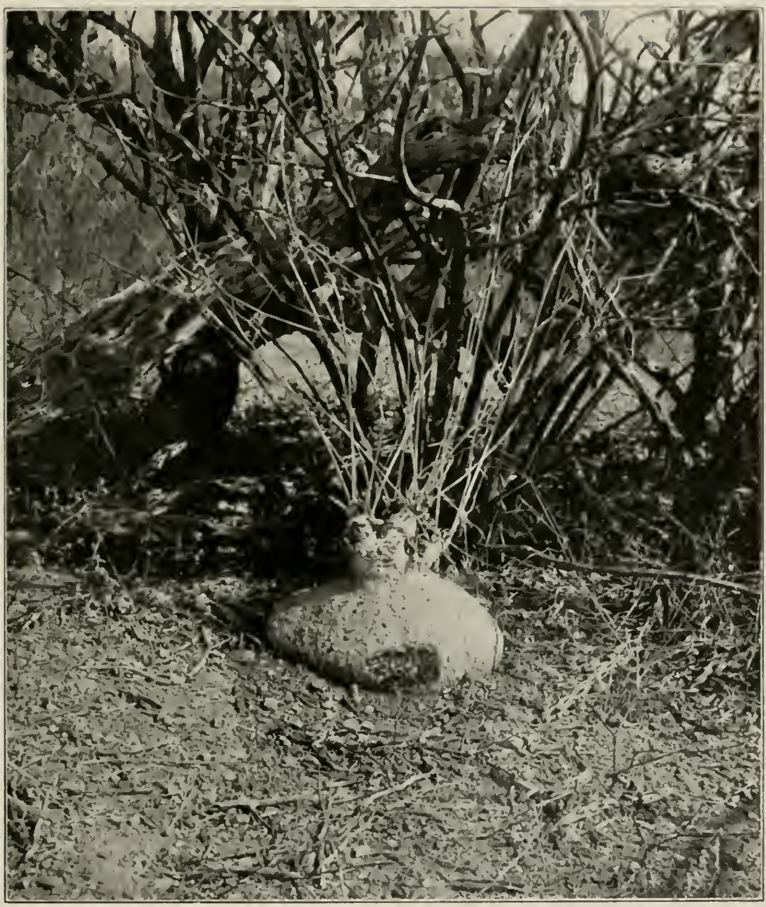

Fig. A. *Ibervillea Sonoræ* in its native habitat.

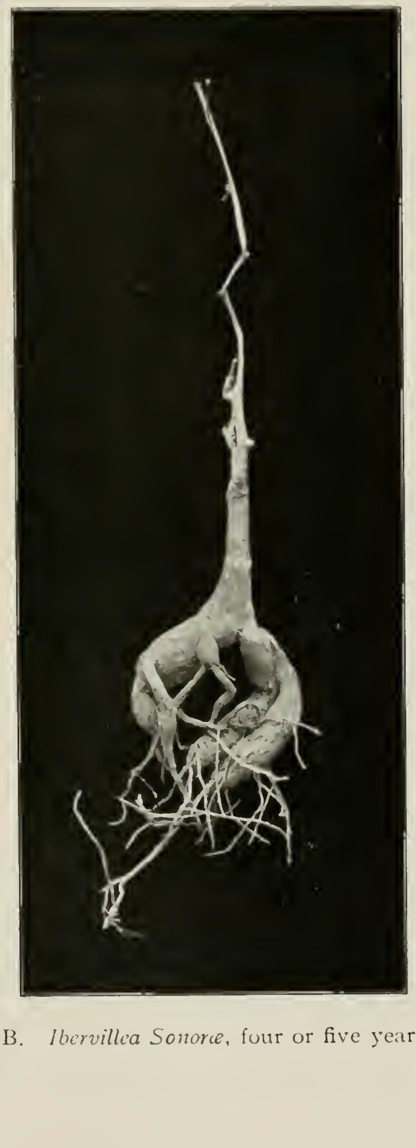

Fig. B. *Ibervillea Sonoræ*, four or five years old.

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CONTRIBUTIONS FROM THE NEW YORK BOTANICAL
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# THE BOLETI OF THE FROST HERBARIUM

By WILLIAM A. MURRILL

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# The Boleti of the Frost herbarium

William A. Murrill

(with plates 36–40)

A brief account of the life and botanical work of C. C. Frost was published in the August number of Torreya, and the reader is referred to that account as a general introduction to the present more critical paper, which was made possible by the recent generous loan of the Frost collection of Boleti by the University of Vermont.

This collection is very rich in type material, containing practically all of Frost's published species and a number of species still in manuscript, which I have treated separately. A number of sheets of type specimens, or type duplicates, twenty or more, were sent to C. H. Peck at Albany, where they are still well preserved. Peck never saw Frost, nor the remainder of his herbarium. He began work near the close of Frost's active life, but his advantages appear to have been greater, and we find Frost turning to him in 1874 for certain determinations and for assistance with the Amherst Catalogue.

There are a number of references in Frost's notes and descriptions to the opinions of Peck regarding various species. There are also four type specimens, or co-types, in the collection, which were sent him by Peck, namely, *B. ampliporus* Peck, *B. gracilis* Peck; *B. elbensis* Peck, and *B. paluster* Peck, but these are now, unfortunately, in very poor condition.

Frost kept a separate list of spore measurements of the Boleti; he was not particular about spore coloration. I have made a careful examination of his types microscopically and find his figures usually correct.

The following commentary represents my present views regarding Frost's published and unpublished species. In connection with the latter, I have purposely avoided the publication of anything that would suggest a description, although Frost's diagnoses are in most cases quite complete.

## PUBLISHED SPECIES

BOLETUS ALBUS Peck.

Represented by three fine plants. The species is only an albino form of *B. granulatus*.

BOLETUS ALVEOLATUS B. & C.

There are no specimens bearing this name in the Frost herbarium. An excellent description, however, of this species was published in the Catalogue of Boleti of New England.

BOLETUS AURIPORUS Peck.

Seven good specimens are found under this name, which Frost always spelled with an extra "*s*" (*aurisporus*), probably because the spores as well as the tubes are yellow. These specimens, now about forty years old, have retained the yellow color in their tubes to a remarkable extent.

BOLETUS BICOLOR Peck.

Represented by eight faded and moulded plants.

BOLETUS BOVINUS L.

Represented by eight fair to poor, more or less moulded, specimens, which may be referred almost certainly to *B. granulatus*.

BOLETUS CASTANEUS Bull.

There are two sheets in the collection, one containing five specimens and the other six, all well preserved.

BOLETUS CHROMAPES Frost.

Represented by seven good plants.

BOLETUS CHRYSENTERON Fries.

Three faded plants represent this very common species.

BOLETUS COLLINITUS Fries.

One sheet contains three very poor plants collected in pine woods in autumn. The other sheet, containing five good specimens, was first labeled "*B. granulatus*" and later changed to *B. collinitus*. The first determination was correct for both sheets.

BOLETUS CYANESCENS Bull.

Six good plants are preserved. Frost has marked it "rare."

BOLETUS DECORUS Frost.

Represented by three good specimens, which may be referred to *B. edulis.*

BOLETUS EDULIS Bull.

One sheet contains two poor plants with their stems eaten away by insects. On the other sheet is one very poor specimen, which may be *B. edulis*, and a fine plant that is certainly *B. ornatipes.* In a letter to Professor Peck, dated Nov. 27, 1874, Frost says: "Have you Curtis' full description of *Boletus retipes*? From all I can gather it seems to me that the specimen I sent you as such is the true one. What you describe as such I suspect is a variety of *B. edulis*, it indeed does it exactly. If Bulliard's figure is the true species, then Sowerby's must be a variety, for they are very much unlike in appearance but microscopically they are the same species. What you describe is abundant here. Unless I greatly mistake, it is another variety of *Boletus edulis.* I am familiar with all three of them."

BOLETUS ELEGANS Schum.

This name is doubtfully assigned by Frost to a specimen from Sprague and to one collected by himself, neither of which is very well preserved. The former is *B. luteus* and the latter is possibly *B. Ravenelii.*

BOLETUS FELLEUS Bull.

One sheet contains a single large plant cut in half. It is well preserved. The other sheet contains five plants, four of them apparently *B. ornatipes*, and a single one, in the lower corner on the right, *B. felleus.*

BOLETUS FERRUGINEUS Frost.

There is one sheet under this name containing five excellent specimens collected in 1867 under oak trees near borders of woods. A full description is written at the bottom of the sheet. I cannot distinguish the species from *B. felleus.* (PLATE 36.)

BOLETUS FIRMUS Frost.

Two poor plants represent this species, which is probably not distinct from *B. luridus* Schaeff. In *B. luridus* the stem is usually punctate, but often reticulate at the top or for some distance downward.

BOLETUS FLAVIDUS Fries.

Most of the specimens appearing under this name in the Frost collection belong to what we know in this country as *B. americanus* Peck. They were collected in pine woods and grassy places, and are mostly very poorly preserved. Twenty specimens are glued to sheets and five are contained in a small paper box. A larger box similarly labeled contains seven good specimens of *B. luteus*.

BOLETUS FLÁVUS With.

Represented by about fifteen moulded specimens in a paper box, which may doubtless be referred to *B. luteus*.

BOLETUS FROSTII Russell.

Represented by six sheets, containing in all twenty-one good plants and seven in fair condition. Where the habitat is mentioned, it is "borders of woods." The name is written "*B. Frosti*" or "*B. Frostii*" indifferently. The species is not distinct from *B. alveolatus*.

BOLETUS GRANULATUS L.

Two sheets, containing ten specimens in a fair state of preservation, represent this common species.

BOLETUS GRISEUS Frost.

Represented by three sheets containing thirteen good specimens. The species was published by Peck in the 29th Report of the N. Y. State Museum of Natural History. Dried specimens may be easily confused with *B. ornatipes*, but the white color of the tubes readily distinguishes it in the field. Frost's notes refer to *B. griseus* with intensely yellow tubes, which was evidently *B. ornatipes*.

BOLETUS INNIXUS Frost.

Represented by a sheet containing three good plants collected in grassy woods in 1866; also a sheet containing two small poorly preserved specimens united at the base. *B. innixus* is plainly an abnormal or distorted form of *B. auriporus*, representing the maximum of size and irregularity in the tubes and a reclining habit not usual in typical plants. The descriptions are practically identical, and the type specimens of *B. innixus* show the characteristic yellow color of the tubes of *B. auriporus* still well preserved. The specimens united at the base suggest another synonym, *B. caespitosus* Peck, in which the subcespitose character and the subcuticular reddish tint were emphasized. (PLATE 37.)

BOLETUS LIMATULUS Frost.

This species, reported rare by Frost, was collected in hilly woods in July, 1869. One sheet contains five fair plants, with full description, and another three plants well preserved. They may all be referred to *B. edulis*.

BOLETUS LUTEUS L.

None of the specimens are good, most of them being moulded. There are three sheets containing fourteen plants, one of the sheets having "*B. flavidus*" written on it in pencil.

BOLETUS MAGNISPORUS Frost.

Represented by three sheets containing six poor specimens collected in woods and thickets. The species is not distinct from *B. luridus*. The spores are oblong-elliptical, decidedly ferruginous-fulvous, 12–16 $\mu \times 4$–$5 \mu$. Frost makes them $16.5 \mu \times 6 \mu$. The color of the spores is probably greenish in fresh specimens.

BOLETUS MINIATO-OLIVACEUS Frost.

Represented by two sheets containing five excellent specimens collected in woods and borders.

BOLETUS ORNATIPES Peck.

Represented by two sheets containing ten good plants. See remarks under *B. edulis*, *B. felleus*, and *B. retipes*.

BOLETUS PALLIDUS Frost.

Represented by three sheets, containing three excellent specimens and six more or less moulded ones. On one sheet is a full description. (PLATE 38.)

BOLETUS PECKII Frost.

This species, published by Peck in the 29th Report, does not appear in the collection.

BOLETUS PICTUS Peck.

See *Boletus Murraii*, in the list of unpublished species.

BOLETUS PIPERATUS Bull.

The collection contains two sheets of this species, one with five poor plants and one with four good ones. The habitat is given as "woods and grass grounds."

BOLETUS RAVENELII B. & C.

There is one sheet with seven excellent specimens, in which even the colors are well preserved. Above "*B. subchromeus* Frost" is written "*B. Ravenelii* B. & C. first by publication."

BOLETUS RETIPES B. & C.

In a copy of his Catalogue presented to Mr. C. G. Pringle in 1876, this name is scratched and replaced by *B. ornatipes*, with the statement that "*B. retipes* is not a good Vermont species." See remarks under *B. edulis*.

BOLETUS ROBUSTUS Frost.

Represented by three good plants collected in 1862 in the borders of shady woods. A full description accompanies the specimens. On account of *Boletus robustus* Fries, described earlier from Costa Rica, Peck assigned a new name, *B. eximius*, to this species.

BOLETUS ROXANAE Frost.

Four fair specimens with full description and an outline sketch appear on one sheet. Another sheet has four good specimens, and still another contains five in fair condition, at least one of which is *B. castaneus*. This same sheet contains also a good specimen of the yellow-stemmed variety of *B. Roxanae*, first reported by Peck as *B. sulfureus* and later changed to var. *auricolor*. *B. multipunctus* Peck is probably not distinct from *B. Roxanae*. (PLATE 39.)

BOLETUS RUBEUS Frost.

Frost found this species in deep woods. There are three sheets, containing eight good plants and four rather poor ones. A study of these various specimens in connection with the description shows the species to be too near *B. bicolor* to be regarded as distinct.

BOLETUS RUSSELLII Frost.

This handsome species is represented by three excellent large plants and five specimens only fairly well preserved. They were collected in moist woods in 1862. (PLATE 40.)

BOLETUS SALMONICOLOR Frost.

Represented by twelve poor specimens collected in the borders of pine woods. This species is apparently synonymous with *B. luteus*.

BOLETUS SATANUS Lenz.

This name appears in an annotated copy of the Amherst Catalogue in Frost's library. It is represented by three sheets, containing seven fair and three poor specimens, none of them distinct from *B. luridus*.

BOLETUS SCABER Bull.

This exceedingly common species is represented by a sheet containing two good plants, and another containing four very poor specimens which are both moulded and eaten by insects. Some of the specimens under *B. versipellis* also probably belong here.

BOLETUS SEROTINUS Frost.

Represented by two sheets containing ten plants rather poorly preserved, collected in 1862 on shady grassy ground late in autumn. The description, habitat, and late habit, as well as the types themselves, point to *B. Clintonianus*, from which this species can hardly be distinct.

BOLETUS SISTOTREMA Fries.

The single specimen bearing this name is so very poor that it suggests no comment. Frost evidently thought he had what Peck listed under this name in the 23d Report, which proved to be a form of *B. piperatus* with large unequal tubes near the stem.

BOLETUS SORDIDUS Frost.

Represented by four rather good plants collected on recently excavated earth in woods in midsummer.

BOLETUS SPADICEUS Schaeff.

Represented by a dozen fair to good specimens, all of which agree well with *B. subtomentosus*. *B. spadiceus* probably does not occur in America.

BOLETUS SPECIOSUS Frost.

This handsome species is well represented by two fine plants cut in half and excellently preserved. Even the color and surface characters of the stem are well shown.

BOLETUS SPRAGUEI Frost.

Represented by two sheets, containing three mature specimens and a cluster of smaller ones, all well preserved. This species is placed by Professor Peck under his *B. vermiculosus*, which is, in turn, only a form of *B. luridus.* Even if Frost's species had been distinct, the name could not have been retained on account of *B. Spraguei* B. & C., published two years previously for *B. pictus* Peck.

BOLETUS STROBILACEUS Scop.

This common species is represented by five good plants. Frost later changed the generic name to *Strobilomyces*, in accordance with Berkeley's classification.

BOLETUS SUBTOMENTOSUS L.

Represented by nine rather poor specimens, some of which may be *B. chrysenteron.*

BOLETUS TENUICULUS Frost.

Three poor specimens represent this species, the central one apparently quite distinct from the other two. The description, also, is very brief, leaving the identity of the species in doubt, unless better authentic specimens exist elsewhere.

BOLETUS UNICOLOR Frost.

This species was published by Peck in 1889 from manuscript only. Frost's collection contains a single sheet with five poor plants, which add little to the description.

BOLETUS VERSIPELLIS Fries.

Represented by six good plants and four that are only fair. They may be only a reddish brown form of *B. scaber.*

BOLETUS VIRIDARIUS Frost.

This species, not distinct from *B. Clintonianus*, was collected on grass plats in October and November. It is represented by a sheet with seven poor specimens and a piece of cardboard containing six good ones.

BOLETUS VISCOSUS Frost.

The collection contains twenty-one plants, all rather poor, collected in pine or fir woods in autumn. They are all alike, with very short stem, well deserving the name *B. brevipes*, assigned them by Peck in the 38th Report, although probably only a form of *B. granulatus.* The name *B. viscosus* was untenable, having already been used by Venturi.

## UNPUBLISHED SPECIES

BOLETUS AUREOBRUNNEUS Frost.

Two sheets, with three good specimens, represent this species, which is synonymous with *B. ornatipes* Peck.

BOLETUS CANUS Frost.

Represented by two sheets, with three good plants and two poor ones. They are probably *B. edulis.*

BOLETUS DIFFRACTUS Frost.

Represented by two poor plants cut in half and hardly worth studying. It is apparently near *B. bicolor.*

BOLETUS FARLOWI Frost.

Three sheets, containing seven good specimens and two very poor ones, represent this species, which is hardly distinct from *B. edulis.*

BOLETUS FLAVO-AUREUS Frost.

Collected in rich woods in August and September, 1867, and represented by five good plants and six that are only fair. On the type sheet is written, "*B. affinis* Peck by first publication."

BOLETUS GLUTINIPES Frost.

Represented by three good plants collected in moist woods in 1863. On the sheet is a good description, and the words, "*aurisporus* Peck by first publication."

BOLETUS GRAMINICOLA Frost.

Three good specimens, collected on grassy ground in October, represent this species, which can hardly be distinct from *B. Clintonianus.* The specific name first selected by Frost was "*graminis*," which was not in good form, and he soon changed it to "*graminicola*".

BOLETUS INTERRUPTUS Frost.

The collection contains three very poor plants of this species, which would hardly repay study, especially as I find no description

BOLETUS LENTICULARIS Frost.

Represented by fifteen good plants, collected during September and October on excavated earth in woods, accompanied by a full description. I see no distinction between this species and *B. subtomentosus.*

BOLETUS MURRAII Frost.

Represented by three sheets, containing five good plants and one poor one, all of which Frost refers to "*B. pictus* Peck by first publication." The following footnote under *B. pictus* in his Catalogue of Boleti explains the change of name:

"This species was discovered several years since by the late Mr. Dennis Murray, of Roxbury, Mass., and named *Boletus Murraii*, B. & C. (C. J. Sprague's MSS.). Under this name I have distributed it. Recently it has been published in the "Grevillea," a London periodical, as *Boletus Spragueii*, B. & C. Mr. Peck, of the New York Botanical Survey, several months before this latter, published it as *Boletus pictus* Peck; therefore his name has the priority."

BOLETUS PALUDOSUS Frost.

Seven good plants and two small poor ones, all collected in marshy woods, represent this species. Both the specimens and the description point to *B. chrysenteron*, from which it can hardly be distinct.

BOLETUS RUBRIPES Frost.

Two sheets containing four fair to poor specimens collected in pine woods are to be found in the collection. The poor specimens and brief description hardly warrant a guess as to its identity, although there is a resemblance to *B. Peckii* in some of the specimens.

BOLETUS SUBCHROMEUS Frost.

The sheet bearing this name contains seven excellent plants collected in moist woods late in autumn, accompanied by a full description. On another sheet this name was changed to *B. Ravenelii* B.C., already published for this species.

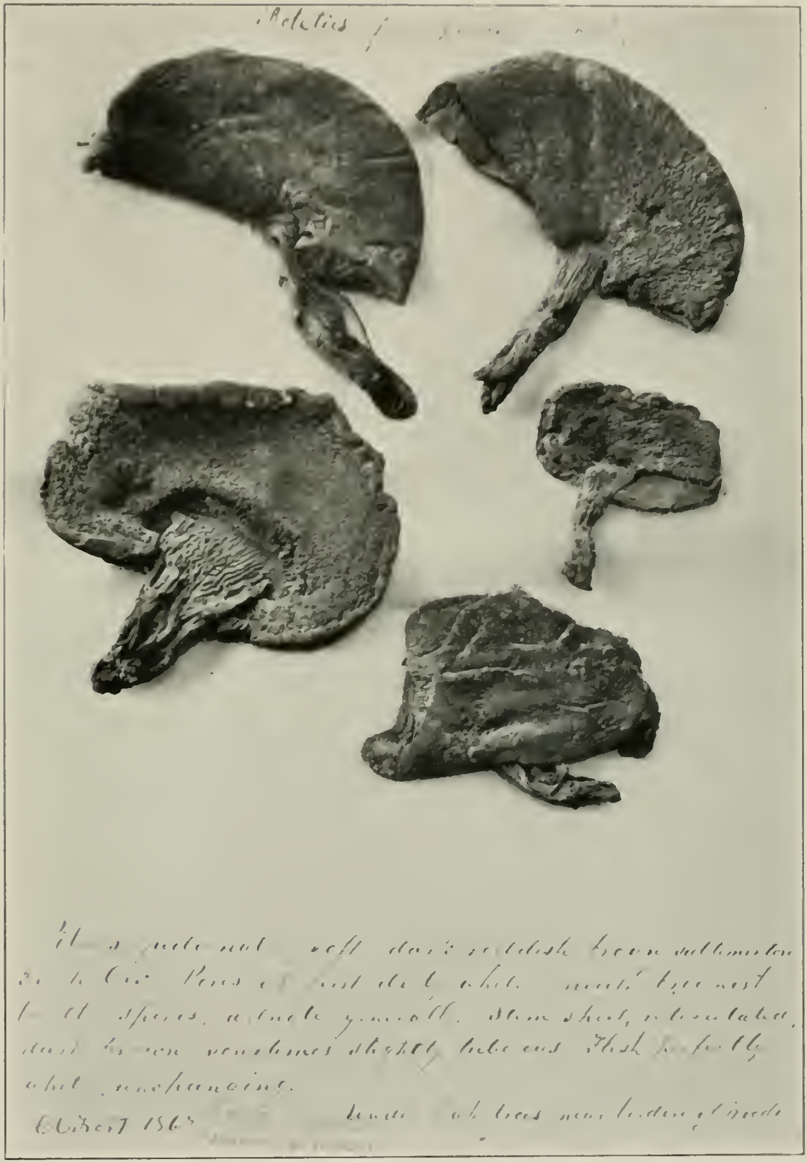
BOLETUS SUBRETICULATUS Frost.

Only one plant is to be found in the collection and this is glued to the sheet with the surface down, and what remains is badly moulded. The description implies a relationship to *B. chrysenteron* or *B. subtomentosus*.

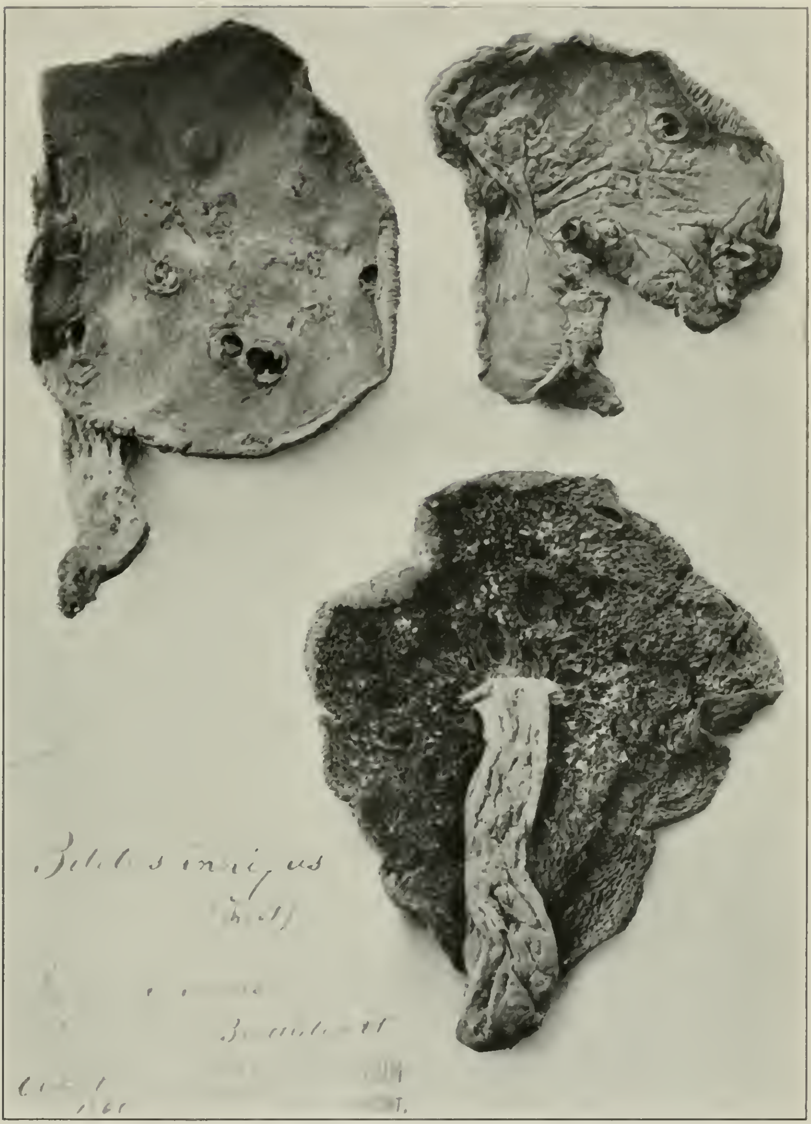
BOLETUS VINACEUS Frost.

Represented by eight poor moulded plants and a full description. Frost refers them to "*B. gracilis* Peck by first publication."

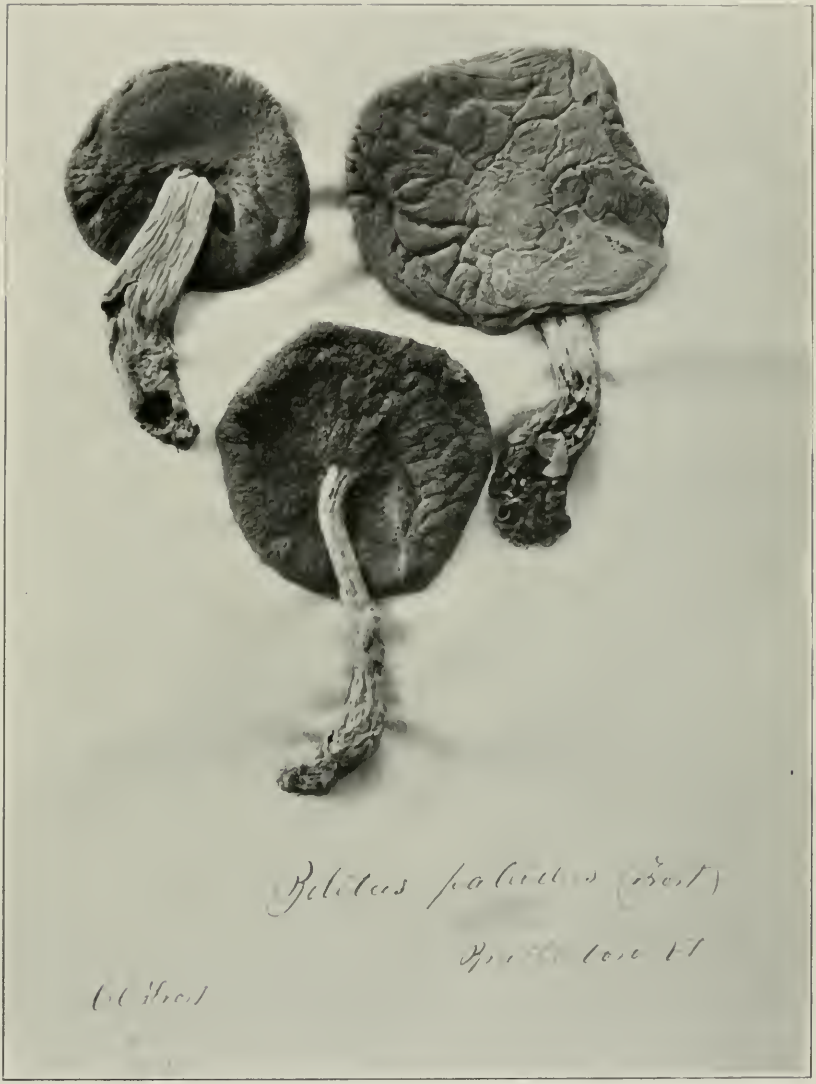
NEW YORK BOTANICAL GARDEN.



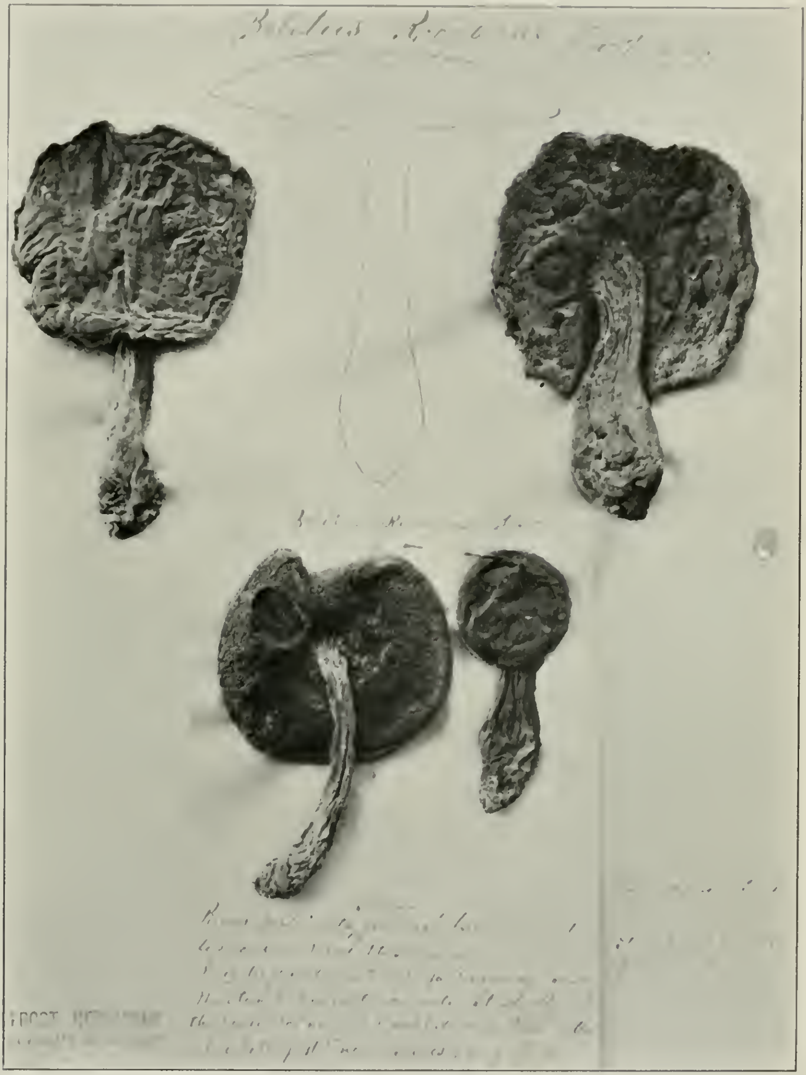
BOLETUS FERRUGINEUS Frost ( × $\frac{2}{3}$ )


Boletus innixus

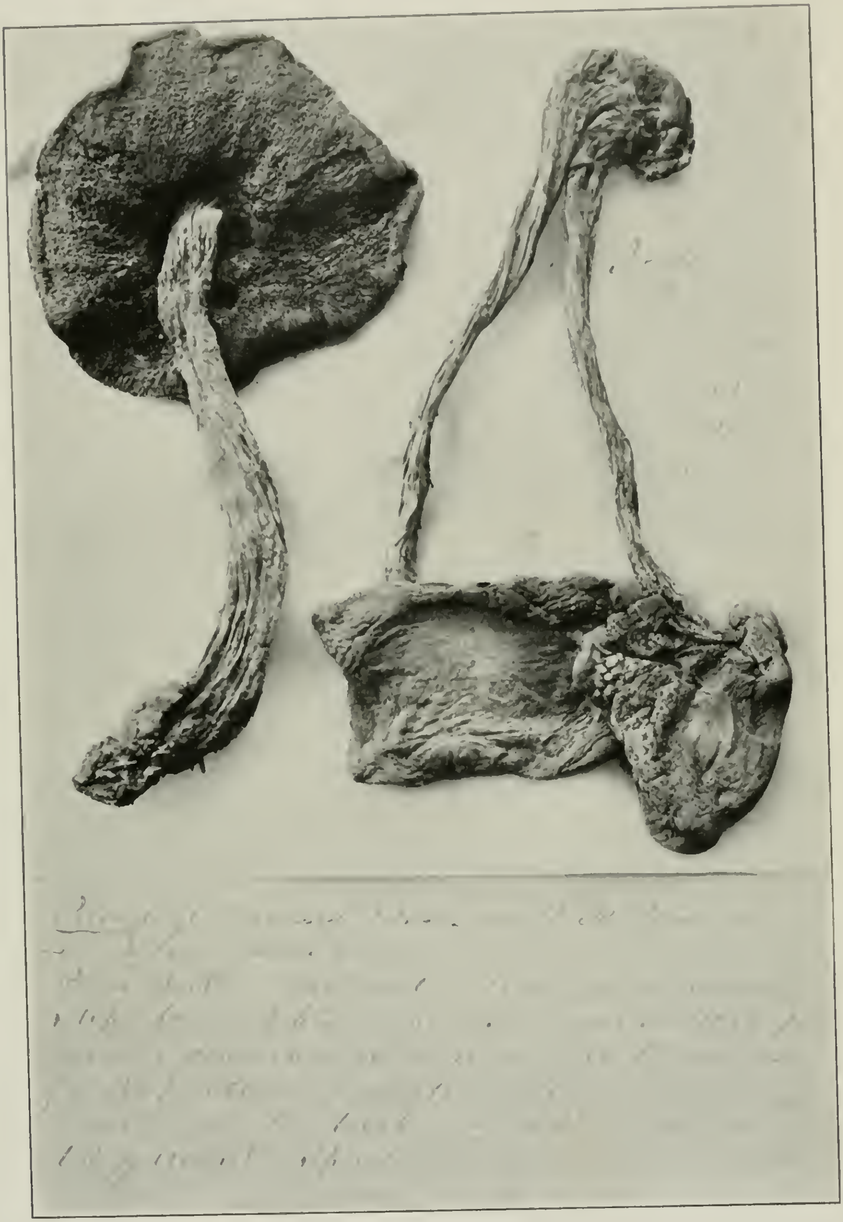
BOLETUS INNIXUS Frost ($\times \frac{7}{8}$)


Boletus pallidus (Frost)
Brattleboro Vt
C. C. Frost

BOLETUS PALLIDUS Frost ( $\times \frac{5}{8}$ )



BOLETUS ROXANAE Frost ( × $\frac{5}{8}$ )



BOLETUS RUSSELLII Frost ($\times \frac{2}{3}$)

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Vol. 25, part 1, issued August 24, 1907. Geraniaceae, Oxalidaceae, Linaceae, Erythroxylaceae.

Vol. 9, parts 1 and 2, issued December 19, 1907, and March 12, 1908. Polyporaceae.

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CONTRIBUTIONS FROM THE NEW YORK BOTANICAL GARDEN—No. 115

# SOME NORTH DAKOTA HYPOCREALES

By FRED J. SEAVER

NEW YORK
1908

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From the Bulletin of the Torrey Botanical Club, 35: 527-533 1908.

# Some North Dakota Hypocreales

Fred J. Seaver

For some time past the writer has been engaged in the preparation of a monograph of the North American Hypocreales and the year spent in North Dakota, in the employ of the North Dakota Agricultural College, afforded a fair opportunity for the study of the various species of this order in that particular locality. While the work on the local fungi of that state was not limited to the order treated here, an especial effort was made to accumulate as much material of this order as possible. All of the species reported here were collected in the summer and autumn of 1907 and the spring of 1908. Most of the material was collected near Fargo, in the extreme eastern part of the state, but several specimens were obtained at Hawk's Nest, a low range of hills near the central part of the state, the ravines of which are shaded by a considerable growth of forest trees.

North Dakota, being essentially a prairie state and having its timbered regions limited to narrow belts along the rivers, lakes, and ravines in mountainous districts, does not afford the most favorable conditions for the growth of those forms of fungi which thrive best in moist shaded places. But notwithstanding the unfavorable conditions, the season spent in work on the fungus flora of this state was rewarded with a surprisingly large number of the saprophytic forms, while parasitic fungi which occur in more open regions were found to be most abundant.

The order Hypocreales is represented by approximately two hundred species in the whole of North America, and it would not be expected that a large number of species of a single order of this size would be collected in a given locality during one season. The list is published at this time, not on account of the large number collected, but to add to the knowledge of the distribution of this order in North America, and since there is little published work on the fungi of North Dakota, it is hoped the list will be of interest to some.

Of the twenty species reported here one at least deserves especial mention. *Nectria tuberculariformis* (Rehm) Winter was collected in the autumn of 1907 on herbaceous stems and one specimen was found in full fruit on the bark of a dead branch. No specimen of this species had previously been seen in the collection of North American Hypocreales examined and up to the present time no record of it from North America has been seen. During the spring of 1908 a quantity of the material was collected on dead stems of nettle, on which host the species has been reported in Europe. The species, while a true stromatic *Nectria*, is specifically very distinct from any of the other forms of the genus that have been examined. The stroma is tubercular, very distinct in outline, and rounded or more often elongated. The perithecia are small and instead of being cespitose on the stroma so as to cover it almost completely, as is usually the case, they are entirely superficial and distributed over its surface, being often scattered but occasionally crowded. The species is of interest not only on account of its distribution but for its peculiar specific characters.

The identification of the species recorded here has been facilitated by access to the collections of the New York Botanical Garden, with its numerous types, as well as by the types that have been received from individuals during the course of the work on the order.

### Synopsis of the genera

- Perithecia free on the substratum, or entirely superficial on a sessile stroma.
  - Perithecia dark blue with transmitted light (nearly black to the naked eye), spores with 3 or more septa. I. GIBBERELLA.
  - Perithecia normally bright colored, of some shade of red, yellow, or brown (often becoming dark with age).
    - Spores 2-celled. II. NECTRIA.
    - Spores muriform. III. PLEONECTRIA
- Perithecia more or less immersed in a common matrix, varying from a cottony subiculum to a distinct fleshy stroma.
  - Matrix consisting of a cottony subiculum in which the perithecia are seated, usually growing on other fungi; spores fusiform. IV. HYPOMYCES.
  - Matrix consisting of a distinct fleshy stroma, sessile or erect; spores filiform or subglobose.
    - Asci 16-spored (by the breaking of each spore into two); spores subglobose; stroma sessile (very rarely erect). V. HYPOCREA.
    - Asci 8-spored; spores filiform, nearly as long as the ascus; stroma erect (very rarely subsessile).

| | |
|---|---|
| Stroma springing from a sclerotium formed in the ovaries of plants. | VI. CLAVICEPS. |
| Stroma springing from the bodies of dead insects, larvae, or underground fungi. | VII. CORDYCEPS. |

## I. GIBBERELLA

GIBBERELLA PULICARIS (Fries) Sacc. Very common on old corn-stalks about Fargo. This fungus is reported to have as its conidial phase species of *Fusarium*. The mature fruit appears on dead materials and its connection with a *Fusarium* suggests a possibility of its association with plant diseases. The life-history of this plant should be more carefully studied.

## II. NECTRIA

### *a*. Perithecia solitary and free on substratum.

NECTRIA PEZIZA (Tode) Fries. This is one of the most common of the non-stromatic forms of *Nectria* and occurs on various kinds of dead materials. It is perhaps most common on decayed wood but is often found on old fungi and one very good specimen was collected in North Dakota on a piece of old burlap sacking. The species is characterized by the rather large nearly globose perithecia which collapse when dried so as to resemble a small *Peziza*, for which the species has often been mistaken. The spores also are characteristic, being broadly elliptical and non-constricted. Various collections were made at Fargo and Hawk's Nest.

NECTRIA EPISPHAERIA (Tode) Fries. On various kinds of sphaeriaceous fungi. The species is distinguished from *Nectria sanguinea* Bolton by its occurrence in this kind of a habitat. The forms occurring on fungi show a strong tendency to collapse from the two opposite sides, which tendency, although less common, is not entirely lacking in young specimens of *Nectria sanguinea* Bolton. It is thought doubtful if the two are specifically distinct. Both are characterized by the blood-red color of the perithecia.

### *b*. Perithecia borne on a stroma, often cespitose.

NECTRIA COCCINEA (Pers.) Fries. Several specimens on dead branches in woods near Fargo. The species is distinguished by the scarlet-red perithecia, borne in clusters on a yellowish stroma.

NECTRIA PURPUREA (L.) Wilson & Seaver.

*Nectria cinnabarina* (Tode) Fries.

On dead branches of various kinds of trees and shrubs. The mature fruit of this plant occurs on dead branches and usually in great abundance, but its conidial phase is reported to be parasitic. The species is recognized by the rough perithecia, which vary in color from rather bright cinnabar-red to dull brownish black and are borne in dense clusters on a tubercular stroma.

NECTRIA VERRUCOSA (Schwein.) Sacc. On dead branches in woods near Fargo. The perithecia and spores of this species are identical with those of the preceding. The species is distinguished by the fact that the stroma is depressed, never rising above the surface of the bark, while in the preceding it is tubercular and very prominent.

NECTRIA TUBERCULARIFORMIS (Rehm) Winter; Rabenh. Krypt. Flora **1**$^2$: 118, 119. 1887.

*Hypocrea tuberculariformis* Rehm, Ber. Naturh. Ver. Augsburg **26**: 106. 1881.

Exsicc.: Rehm, Ascom. *435*, *679*.

Other specimens examined: N. Dakota, *Seaver*, various collections.

Habitat: Herbaceous stems (especially *Urtica* sp.), bark, and dung.

Stroma tubercular, rounded or more usually elongated, nearly smooth or in dried specimens often longitudinally striated, pinkish or rose-colored, becoming dull red with age.

Perithecia superficial, solitary or more or less crowded, small, averaging about 200 $\mu$ in diameter, smooth or nearly so, globose with a rather prominent ostiolum, delicately rose-colored, becoming slightly collapsed from above when dry; asci clavate, 8-spored, about 40–50 $\mu \times$ 6–7 $\mu$; spores 1- or 2-seriate, mostly 2-seriate above and 1-seriate below, usually a little broader above, fusoid, and a little constricted at the septum, with two or more small oil-drops in each cell, 8–11 $\mu \times$ 3–4 $\mu$.

The conidial phase is often very abundant but the mature fruit is less common.

## III. PLEONECTRIA

PLEONECTRIA BEROLINENSIS Sacc. On dead branches of red currant in the Agricultural College Gardens and also on branches of wild black currant in woods near Fargo. Very destructive to currants in cultivation. In external appearance the plants of this species very closely resemble those of *Nectria purpurea* (L.) W. & S. but the species is very distinct in the spore characters. The spores instead of being 2-celled are divided both longitudinally and transversely into numerous cells.

## IV. HYPOMYCES

HYPOMYCES AURANTIUS (Pers.) Fuckel. On decaying fungi of various kinds. Various collections, Fargo and Hawk's Nest. The fungus presents to the naked eye a rusty red appearance due to the cottony stroma, which spreads over the substratum often for several inches. Closer examination will show the orange-colored perithecia scattered over the stroma. The species is rather common.

HYPOMYCES LACTIFLUORUM (Schwein.) Tul.

*Hypomyces purpureus* Peck.

On some agaric in woods near Fargo. The stroma of this plant, which entirely covers the hymenium of the host infected, presents an orange-yellow color. Scattered over the orange surface are the perithecia, which are nearly immersed, with necks protruding. As the plants of the host decay, they become purple, which accounts for the specific name of the synonym given above. The species was found to be abundant in one locality.

HYPOMYCES OCHRACEUS (Pers.) Tul. On some agaric in same locality as preceding. The plants differ from the preceding by the fact that the stroma is almost entirely white when fresh, becoming yellowish as it dries. There is also a marked difference in the spores.

HYPOMYCES POLYPORINUS Peck. On old plants of *Coriolus versicolor*, in woods near Fargo. The plants of this species occur on the under surface of the host and would scarcely be seen except by accident or special search. Characterized by the amber color of the perithecia and the habitat as well as by spore characters. Found in considerable abundance. I am indebted to Professor C. H. Peck for an authentic specimen of this species for comparison.

HYPOMYCES ROSELLUS (Albert. & Schwein.) Tul. Several collections on the under side of rotten logs in woods near Fargo.

The species is well marked by the delicate rose color of the subiculum and perithecia as well as by spore characters.

## V. HYPOCREA

HYPOCREA CITRINA (Pers.) Fries. On dead limbs of basswood, especially where the outer bark has been removed. Plants form a bright lemon-yellow stroma, often several inches in extent on the substratum. The perithecia are seen as little dots over the surface of the stroma. The plants resemble those of the preceding genus but are readily distinguished by the spore characters. Considerable quantity of this material has been collected but always on the same host.

HYPOCREA PATELLA Peck. The stroma in this species is very small as compared with the preceding and not so bright-colored. In the specimens of this species collected, it seems to show a tendency to grow on old sphaeriaceous fungi. This has been compared with specimens identified by Professor Peck.

HYPOCREA RICHARDSONI Berk. & Mont. Very common on limbs of *Populus tremuloides* in woods near Fargo. No perithecia have been seen in any of the specimens which have been examined. Although in external appearance the plants resemble a *Hypocrea*, it is doubtful if they rightfully belong to this genus.

HYPOCREA RUFA (Pers.) Fries. The specimens which were collected in Fargo were small and not fair examples of this species, but they seem to belong here.

## VI. CORDYCEPS

CORDYCEPS MILITARIS (L.) Link.
*Isaria farinosa* Fries.

On larvae of insects in Fargo woods. Only the conidial phase of this plant was collected in North Dakota but that occurred in considerable abundance and doubtless the mature fruit would have appeared at the proper season. The conidial phase is characterized by the snow-white feather-like growth, with its yellowish stem which springs from larvae that are buried under leaves and soil.

CORDYCEPS PISTILLARIAEFORMIS Berk. & Broome. On scale-insects on branches of *Xanthoxylum americanum* in woods about Fargo. The plants of this species collected do not show mature asci and spores but otherwise correspond well with other specimens of this species that have been examined.

## VII. CLAVICEPS

CLAVICEPS PURPUREA (Fries) Tul. The species was collected by the writer on several hosts including *Bromus*, *Agropyron*, and cultivated rye, in the Agricultural College grounds. The fungus is a parasite and besides causing some reduction in the crop is also the cause of a characteristic disease among cattle. It is used as an official drug under the name of ergot.

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CONTRIBUTIONS FROM THE NEW YORK BOTANICAL
GARDEN—No. 116

# NOTES ON ROSACEAE—I.

By PER AXEL RYDBERG

NEW YORK
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# Notes on Rosaceae — I

PER AXEL RYDBERG

The author has thought it advisable to publish a series of notes on this family, supplementary to his monograph in the North American Flora, vol. 22, beginning on page 239. The reasons for so doing, are:

1. The plan of the North American Flora does not allow many critical notes and explanations, and many facts worthy of presentation must necessarily be omitted on account of lack of space.

2. It is not always evident from the synonymy alone, why a certain name should be adopted in preference to another.

3. It is often desirable to present the author's reasons for his limitation of genera and species.

4. In the North American Flora, only the types of new species are given. It is often desirable to cite some more specimens, which would help in identification of these species, when the types are not accessible.

## OPULASTER Medic.

There may be some doubt as to whether this genus was properly published. The original publication consists only of citing *Spiraea opulifolia* L. as a synonym of *Opulaster bullatus* Medic. *Icotorus* Raf., *Epicostorus* Raf., and *Physocarpa* Raf., were published in about the same way. The only name for the genus, which was accompanied by an adequate description, was *Physocarpus* Maxim.; but this, as well as *Physocarpa* Raf., is invalidated by the older *Physocarpon* Necker,* and *Physocarpum* Bercht. & Presl,† which both have Latin diagnoses. Under the latter, there are also two species named and described. There is, therefore, no alternative left but the retaining of *Opulaster* as the name of the genus, unless the making of a new name is preferred.

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* Elem. Bot. 2: 164. 1790.

† Rostl. 1: Ranunc. 14. 1823.

In the North American Flora, thirteen species of *Opulaster* are admitted. Of these, nine are previously known species, while four are proposed as new. Of the more recently described species, *Physocarpus michiganensis* Daniels, and *P. missouriensis* Daniels, were placed as synonyms under *O. opulifolius* and *O. intermedius*, respectively. The only distinctive character given by Daniels is the pubescence, which is said to consist of stellate hairs in his two new species; while the two older species should have glabrous leaves or pubescent ones with simple hairs. In none of the species of this genus are the hairs normally simple; only occasionally simple hairs are found. While in *O. opulifolius* the leaves are usually glabrous or nearly so, they are in *O. intermedius* usually quite pubescent, .and the hairs commonly branched. If the amount of pubescence should be regarded as a distinctive specific character in *Opulaster*, then *Spiraea ribifolia* Nutt., or *Neillia opulifolia multiflora* Durand, should be regarded as a distinct species from *O. capitatus*, and *O. pubescens* Rydb. from *O. malvaceus* (Greene) Kuntze.

*Spiraea ribifolia* Nutt., the more glabrate form of *O. capitatus*, has often been confused with *O. opulifolius*, and it is this form that has caused the error of including the Pacific coast in the range of *O. opulifolius*, which is confined to the Alleghanian region. The amount of pubescence is indeed of very little value, and the only reliable characters by which to distinguish the eastern species from its western ally are the long caruncle in the former and the different shapes of the leaves, especially those of the sterile shoots.

As stated above, *O. pubescens* Rydb. is reduced to a synonym of *O. malvaceus*. *O. Ramaleyi* A. Nelson is made a synonym of *O intermedius*, while in my Flora of Colorado it was regarded as the same as *O. bracteatus* Rydb. The first specimen cited by Nelson belongs to *O. bracteatus*, but it does not agree with the description of the carpels. All the other specimens cited agree with said description, and these belong to *O. intermedius*. *O. Ramaleyi* should therefore be regarded as the same as that species.

The four new species described are: *O. australis*, related to *O. opulifolius* and *O. capitatus*; *O. cordatus*, related to *O. intermedius*; *O. alabamensis*, related to *O. stellatus*; and *O. Hapemanii*, related to *O. monogynus*.

*O. australis* resembles a small *O. opulifolius*, but it has the short caruncle of the western *O. capitatus*. Its carpels are only about half the size of those of either of the two species mentioned. *Spiraea caroliniana*, mentioned in Marshall's Arbustum, may belong here, but that species was evidently never published. To *O. australis* belong, beside the type given, the following specimens:

North Carolina: Craggy Mountain, July 8 and Sept. 8, 1897, *Biltmore Herbarium 1282 b.*

Virginia: Summit, Stony Man Mountain, Aug. 13, 1901, *E. S. & Mrs. Steele 170;* Peaks of Otter, June 6, 1890, *A. Brown, T. Hogg, &c.*

In the herbarium of the New York Botanical Garden there is a specimen, received from the herbarium of P. V. LeRoy, and according to the label collected in Mexico by Vischer, in 1838. This has even smaller flowers than *O. australis.* As *Opulaster* is otherwise unknown from Mexico, there was probably a mistake in labeling or a misplacement of labels, and the specimen probably came from some other place. This specimen was therefore ignored when the manuscript for the North American Flora was prepared.

*O. cordatus* is most closely related to *O. intermedius*, but the two species differ in the form of the leaves and the ranges of the two are widely separated. Besides those of the type collection, given in the Flora, only the following specimens may be doubtfully referred to it:

California: Portola, July, 1903, *Elmer 4804.*

*O. alabamensis* is somewhat intermediate between *O. stellatus* and *O. intermedius*, but differs from both in the shape of the leaves, especially those of the sterile shoots. To *O. alabamensis* belong the following specimens:

Alabama: Auburn, Sept., 1900, *Lloyd & Earle;* April 17, 1897, *Earle & Baker;* July 11, 1896, *Earle & Underwood.*

South Carolina: Sandy river bottom, Clemson College, May 20, 1906, *H. D. House 2175;* Six Miles Creek, May 19, 1907, *3383.*

*O. Hapemanii* might be a hairy form of *O. monogynus*, just as *O. opulifolius*, *O. intermedius*, *O. capitatus*, and *O. malvaceus* have strongly pubescent and almost glabrous forms. *O. Hapemanii* is, however, so unlike *O. monogynus* in habit that it was thought advisable to give it a distinct name. In many respects it resembles strongly *O. alternans*, and the author has entertained the thought that it might be a 2-carpellary form of that species. The styles in *O. Hapemanii* are, however, more or less spreading, while in *O. alternans* the style is erect, showing that the latter is related to *O. malvaceus*. Besides the type, the following specimens may be referred to *O. Hapemanii*:

Wyoming: Hartville, July 20, 1894, *Aven Nelson 498*.

The following specimens are referred to *O. alternans*:

Utah: Provo, Wahsatch Mountains, June 16, 1902, *Goodding 1159*; Stansbury's Island, June 26, 1850, *Stansbury*.

Nevada: East Humboldt Mountains, *S. Watson*.

Mr. A. A. Heller adopted the name *O. pauciflorus* for *O. malvaceus*. It is true that the original specimens of *Spiraea pauciflora* Nutt. belong to this species; but *S. pauciflora* was never properly published, only mentioned as a synonym under *S. opulifolia pauciflora* in Torrey and Gray's Flora. This variety was, however, primarily based on *S. monogyna* Torr., and hence belongs rather to *O. monogynus*.

## SPIRAEA

*Spiraea parvifolia* Benth. is a very strange and interesting species. Maximowicz referred it to the section (now the genus) *Petrophytum*. It is, however, a true *Spiraea*, notwithstanding the racemose inflorescence and the entire leaves. Neither has it the depressed habit nor the fruit of *Petrophytum*. As far as is known to me, it has been collected but once. By the courtesy of the director of the Kew Gardens, England, the New York Botanical Garden has received an excellent drawing of the type and some fragments of the plant, enough to show its real character. Unfortunately, *S. parvifolia* Benth. is antedated by *S. parvifolia* Raf. I therefore took pleasure in naming the plant *S. Hartwegiana*, after the discoverer.

The species which appeared in the North American Flora under the name *S. Steveni* has had a peculiar history. The older botanists referred it to *S. chamaedryfolia* L., a species with the flowers in simple corymbs, instead of in flat-topped panicles. Later, it was referred, together with *S. corymbosa*, *S. lucida*, *S. splendens*, and *S. densiflora*, to the Siberian *S. betulifolia*. Dr. E. L. Greene apparently was the first one to point out that the Alaskan species differed from all the other North American relatives in having reflexed sepals. As this is a character found in the original *S. betulifolia* he removed from that species all but the Alaskan plant. The latter, however, differs considerably from Pallas's figure of *S. betulifolia*, and also from Siberian specimens of the same in the Torrey Herbarium. After some search among the literature on the genus, I found that the Alaskan plant had been described by C. K. Schneider. That *S. Steveni* is distinct from *S. betulifolia*, is evident. There may be some doubt, however, whether it is specifically distinct from *S. Beauverdiana* of which Schneider made it a variety. I have seen no specimens of *S. Beauverdiana*, but from the characters given by Schneider, it seems distinct enough.

It is strange that the oldest specific name and publication of the beautiful little shrub of the mountains of California and Oregon, usually known as *S. arbuscula*, should have been overlooked so generally. Only in a single one of the later German works on woody plants is the name mentioned; and still, *S. splendens* Baumann was amply published.

To *S. Helleri*, I refer, besides the type, the following specimens:

California: Summit, Central Pacific Railroad, July, 1877, *H. Edwards*.

*S. japonica* is occasionally found escaped from cultivation. I have seen the following specimens:

Pennsylvania: Point Pleasant, July 11, 1898, *C. D. Fretz;* Liberty, September 1, 1906, *J. K. Small*.

*S. salicifolia* is not found native on this continent. What has gone under that name, is partly *S. latifolia*, and partly *S. alba*. The former is distinguished by its broad, obovate or oblanceolate leaves and almost glabrous inflorescence. When the flowers first open, they are usually more or less pinkish; but in age they become white. Even in "Gray's New Manual," *S. alba* is described as *S. salicifolia*. The two resemble each other in the narrower leaves and the pubescent inflorescence, but differ in the flowers, which in *S. alba* are white instead of deep pink, and in the leaves, which are broader above instead of below or at the middle.

In Canada and northern New England and New York there is a form of *S. latifolia*, growing in rocky places, especially along streams, with short broad leaves, rounded at the apex and coarsely toothed. It is also much lower than the ordinary *S. latifolia*, and the stems usually die back each year to near the base. This was described as *S. obovata* by Rafinesque. Usually it is very unlike the ordinary *S. latifolia*, but intermediate forms are not infrequent. This form needs more field study..

In the North America Flora, there are five new species proposed. These, together with *S. pyramidata*, the author is inclined to regard as hybrids, except *S. Helleri*. Hybrids are not uncommon in the genus *Spiraea*. *S. Nobleana* was described by J. D. Hooker from a plant raised in a California nursery. It is supposed to be a hybrid between *S. Douglasii* and *S. salicifolia*. As one of the supposed parents is a native of North America and the other is occasionally found spontaneously, and as the plant originated in America apparently without the help of man, it might have been included in the North American Flora, but it was excluded therefrom, like all other garden plants. The native species of probable hybrid origin and their probable parents are as follows:

*S. roseata* = *S. Menziesii* × *densiflora*.
*S. subvillosa* = *S. Douglasii* × *densiflora*.
*S. tomentulosa* = *S. Douglasii* × *lucida*.
*S. pyramidata* = *S. Menziesii* × *lucida*.
*S. subcanescens* = *S. tomentosa* × *alba*.

*Spiraea tomentulosa*, and *S. subcanescens* are known only from the type locality. *S. subvillosa* has been collected also at the following station:

Oregon: Hood River, Cascade Mountains, Aug. 1, 1894, *F. E. Lloyd*.

*S. roseata* has been collected at the following locality:

Idaho: Near Cooper's, July 20, 1892, *Isabel Mulford*.

## PETROPHYTUM AND KELSEYA

It is gratifying to the author, that C. K. Schneider,* a rather conservative dendrologist, has independently raised these to generic rank. The genera are related to *Spiraea*, but are distinguished by the peculiar habit and by the structure of their fruits. To merge them into *Eriogynia*, or *Luetkea*, as was done by S. Watson, O. Kuntze, and E. L. Greene, is rather indefensible; and it is strange that A. A. Heller, who recognized *Petrophytum caespitosum* and *P. elatior* as representing a distinct genus, should transfer the closely related *Spiraea cinerascens* to *Luetkea*. In the Flora are recognized five species of *Petrophytum*. Of these one, viz., *P. acuminatum*, is proposed as new. It is known only from the type locality. *Kelseya* is monotypic.

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* Handb. Laubh. 1: 484, 485. 1905.

### LUETKEA

It is doubtful which of the two names, *Luetka* or *Eriogynia*, is the older. Otto Kuntze, when adopting *Luetkea* instead of *Eriogynia*, claimed that the former was published in 1831 and the latter in 1833. It is most probable that they were both published in 1832. The part of the Memoirs of the Academy of St. Petersburg in which Bongard's paper on the vegetation of Sitka was published, appeared in August, 1832. Whether any separates were distributed before that time we can not ascertain. *Eriogynia* was published in 1832, apparently in the later part of the year, but the exact date is unknown. For that reason I did not change the now accepted name of the genus.

The generic name was originally spelled *Lütkea*. As the German *ü* is not found in Latin, it is usually replaced by *ue*. *Luetkea* is therefore preferable to *Lutkea*.

### ARUNCUS

The plants of this genus native to the eastern United States have invariably much smaller fruit than the European plants. The plant common in the Alleghanies has thinner, more glossy leaves and rather thick fruit. It is *Aruncus sylvestris americanus* of Maximovicz, but unfortunately the synonym, *Spiraea Aruncus americana* Pers., from which Maximovicz adopted the name, is very doubtful. It may belong, as well as all the synonyms under *A. alleghanensis*, except the last, to *Astilbe* instead of *Aruncus*. Hence a new name was proposed.

The *Aruncus* of the Mississippi valley has rather thick, densely pubescent leaves and more slender fruit. It was described under the name of *A. pubescens*.

The plant of northwestern North America is much closer to the European *Aruncus Aruncus*, and differs practically only in the long-acuminate leaflets. If any of the American species of *Aruncus* should be reduced to the Old World species, it should be *A. acuminatus*. *A. Aruncus* is common in cultivation and rarely escaped.

To these four species is to be added an East Siberian species *A. kamchaticus*, which has been collected on *Attu*, the most westerly of the Aleutian Islands.

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# STUDIES IN NORTH AMERICAN PERONOSPORALES—IV.

## HOST INDEX

BY GUY WEST WILSON

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# Studies in North American Peronosporales — IV. Host index

Guy West Wilson

The present host index of the North American species of the order Peronosporales has been prepared with a view of bringing together in a convenient form for reference all the published hosts of these fungi. The list has been made as complete as possible and such cross-references as will facilitate its use are given, while care has been taken not to overburden the index with useless synonyms. No new hosts are recorded in this index and no attempt is made to unravel tangles of synonymy or specific limitations, but the index represents as completely as possible our present knowledge of the host distribution of the commonly recognized American species of the order.

### AIZOACEAE

Trianthema Portulacastrum L.
*Albugo Trianthemae* G. W. Wilson.

### ALLIACEAE

Allium Cepa L.
*Peronospora Schleideni* Unger.

### ALSINACEAE

Cerastium cerastioides (L.) Britton.
*Peronospora Alsinearum* Caspary.

Cerastium longipedunculatum Muhl.
*Peronospora Alsinearum* Caspary.

Cerastium nutans Raf.; see *C. longipedunculatum* Muhl.

Cerastium trigynum Vill.; see *C. cerastioides* (L.) Britton.

Cerastium viscosum L.
*Peronospora Alsinearum* Caspary.

Cerastium vulgatum L.
*Peronospora Alsinearum* Caspary.

Cerastium sp.
*Peronospora Alsinearum* Caspary.

Silene antirrhina L.
*Peronospora Arenariae macrospora* Farl.

Silene sp.
*Peronospora Arenariae macrospora* Farl.

Spergula arvensis L.
*Peronospora Alsinearum* Caspary.

Tissa leucantha (Robins.) Greene.
*Albugo Lepigoni* (de Bary) Kuntze.

Tissa marina (L.) Britton.
*Albugo Lepigoni* (de Bary) Kuntze.

### ALLIONIACEAE

Allionia incarnata L.; see *Wedelia incarnata* (L.) Kuntze.

Allionia nyctaginea Michx.
*Peronospora Oxybaphi* E. & E.

Boerhaavia anisophylla A. Gray.
*Albugo platensis* (Speg.) Swingle.

Boerhaavia diffusa L.
*Albugo platensis* (Speg.) Swingle.

Boerhaavia erecta L.
*Albugo platensis* (Speg.) Swingle.

Boerhaavia hirsuta Willd.
*Albugo platensis* (Speg.) Swingle.

Boerhaavia paniculata Rich.
*Albugo platensis* (Speg.) Swingle.

Boerhaavia Sonorae Rose.
*Albugo platensis* (Speg.) Swingle.

Boerhaavia spicata Choisy.
*Albugo platensis* (Speg.) Swingle.

Boerhaavia viscosa Lag. & Rodr.
*Albugo platensis* (Speg.) Swingle.

Boerhaavia Xanti S. Wats.
*Albugo platensis* (Speg.) Swingle.

Oxybaphus nyctagineus Sweet; see *Allionia nyctaginea* Michx.

Wedelia incarnata (L.) Kuntze.
*Albugo platensis* (Speg.) Swingle.

## AMARANTHACEAE

Acnida cannabina L.
*Albugo Bliti* (Biv.) Kuntze.
Acnida tamariscina (Nutt.) Willd.
*Albugo Bliti* (Biv.) Kuntze.
Acnida tamariscina tuberculata (Moq.) Uline & Bray.
*Albugo Bliti* (Biv.) Kuntze.
Acnida tuberculata Moq.; see *A. tamariscina tuberculata* (Moq.) Uline & Bray.
Amaranthus albus L.; see *A. graecizans* L.
Amaranthus Bigelovii Uline & Bray.
*Albugo Bliti* (Biv.) Kuntze.
Amaranthus blitoides S. Wats.
*Albugo Bliti* (Biv.) Kuntze.
Amaranthus chlorostachys L.; see *A. hybridus* L.
Amaranthus crispus (Lesp. & Thev.) Braun.
*Albugo Bliti* (Biv.) Kuntze.
Amaranthus emarginatus Salzm.
*Albugo Bliti* (Biv.) Kuntze.
Amaranthus graecizans L.
*Albugo Bliti* (Biv.) Kuntze.
Amaranthus hybridus L.
*Albugo Bliti* (Biv.) Kuntze.
Amaranthus hybridus paniculatus (L.) Uline & Bray.
*Albugo Bliti* (Biv.) Kuntze.
Amaranthus Palmeri S. Wats.
*Albugo Bliti* (Biv.) Kuntze.
Amaranthus paniculatus L.; see *A. hybridus paniculatus* (L.) Uline & Bray.
Amaranthus retroflexus L.
*Albugo Bliti* (Biv.) Kuntze.
Amaranthus spinosus L.
*Albugo Bliti* (Biv.) Kuntze.
Amaranthus tristis L.
*Albugo Bliti* (Biv.) Kuntze.
Amaranthus viridis L.
*Albugo Bliti* (Biv.) Kuntze.
Amaranthus sp.
*Albugo Bliti* (Biv.) Kuntze.
Cladothrix lanuginosa (Moq.) Nuttall.
*Albugo Froelichiae* G. W. Wilson.
"Cyathula lappulacea."
*Albugo Bliti* (Biv.) Kuntze.
Froelichia campestris Small.
*Albugo Froelichiae* G. W. Wilson.
Froelichia Floridana (Nutt.) Moq.; see *F. campestris* Small.
Froelichia gracilis Moq.
*Albugo Froelichiae* G. W. Wilson.

## AMBROSIACEAE

Ambrosia artemisiaefolia L.
*Albugo Tragopogonis* (DC.) S. F. Gray.
*Rhysotheca Halstedii* (Farl.) G. W. Wilson.
Ambrosia psilostachya DC.
*Albugo Tragopogonis* (DC.) S. F. Gray.
*Rhysotheca Halstedii* (Farl.) G. W. Wilson.
Ambrosia trifida L.
*Albugo Tragopogonis* (DC.) S. F. Gray.
*Rhysotheca Halstedii* (Farl.) G. W. Wilson.
Ambrosia sp.
*Albugo Tragopogonis* (DC.) S. F. Gray.
Franseria discolor Nutt.; see *Gaertneria discolor* (Nutt.) Kuntze.
Franseria tenuifolia A. Gray; see *Iva ambrosiaefolia* A. Gray.
Gaertneria acanthocarpa (Hook.) Britton.
*Albugo Tragopogonis* (DC.) S. F. Gray.
Gaertneria discolor (Nutt.) Kuntze.
*Albugo Tragopogonis* (DC.) S. F. Gray.
Iva ambrosiaefolia A. Gray.
*Albugo Tragopogonis* (DC.) S. F. Gray.
Iva ciliata Willd.
*Albugo Tragopogonis* (DC.) S. F. Gray.
Iva xanthiifolia Nutt.
*Basidiophora Kellermanii* (E. & H.) G. W. Wilson.
*Rhysotheca Halstedii* (Farl.) G. W. Wilson.
Xanthium canadense Mill.
*Rhysotheca Halstedii* (Farl.) G. W. Wilson.

## APIACEAE

"Umbelliferae" gen. et sp. ignot.
*Rhysotheca Umbelliferarum* (Caspary) G. W. Wilson.

## ARACEAE

Caladium Colocasia (L.) W. F. Wight.
*Peronospora trichomata* Massee.
Colocasia Antiquorum Schott; see *Caladium Colocasia* (L.) W. F. Wight.

## ASCLEPIADACEAE

Gonolobus macrophyllus Michx.; see *Vincetoxicum gonocarpos* Walt.
Gonolobus suberosus (L.) R. Br.; see *Vincetoxicum suberosum* (L.) Britton.
Gonolobus sp.; see *Vincetoxicum hirsutum* (Michx.) Britton.
Vincetoxicum gonocarpos Walt.
*Rhysotheca Gonolobi* (Lagerh.) G. W. Wilson.
Vincetoxicum hirsutum (Michx.) Britton.
*Rhysotheca Gonolobi* (Lagerh.) G. W. Wilson.
Vincetoxicum suberosum (L.) Britton.
*Rhysotheca Gonolobi* (Lagerh.) G. W. Wilson.
Vincetoxicum sp.; see *V. hirsutum* (Michx.) Britton.

## BALSAMINACEAE

- Impatiens aurea Muhl.
  - *Rhysotheca obducens* (Schröt.) G. W. Wilson.
- Impatiens biflora Walt.
  - *Rhysotheca obducens* (Schröt.) G. W. Wilson.
- Impatiens fulva Nutt.; see *I. biflora* Walt.
- Impatiens pallida Nutt.; see *I. aurea* Muhl.
- Impatiens sp.
  - *Rhysotheca obducens* (Schröt.) G. W. Wilson.

## BORAGINACEAE

- Cynoglossum officinale L.
  - *Peronospora Cynoglossi* Burrill.
- Echinospermum Redowskii cupulatum A. Gray; see *Lappula cupulata* (A. Gray) Rydb.
- Echinospermum Redowskii occidentale S. Wats.; see *Lappula occidentalis* (S. Wats.) Greene.
- Lappula cupulata (A. Gray) Rydb.
  - *Peronospora Echinospermi* Swingle.
- Lappula floribunda (Lehm.) Greene.
  - *Peronospora Echinospermi* Swingle.
- Lappula occidentalis (S. Wats.) Greene.
  - *Peronospora Echinospermi* Swingle.
- Lappula texana (Scheele) Britton.
  - *Peronospora Echinospermi* Swingle.
- Myosotis verna Nutt.
  - *Peronospora Myosotidis* de Bary.

## BRASSICACEAE

- Arabis furcata S. Wats.
  - *Albugo candida* (Pers.) Rouss.
- Arabis glabra (L.) Bernh.
  - *Albugo candida* (Pers.) Rouss.
- Arabis hirsuta Scop.
  - *Peronospora parasitica* (Pers.) de Bary.
- Arabis Holboellii Hornem.
  - *Peronospora parasitica* (Pers.) de Bary.
- Arabis lyrata L.
  - *Albugo candida* (Pers.) Rouss.
- Arabis virginica (L.) Trel.
  - *Albugo candida* (Pers.) Rouss.
- Arabis sp.
  - *Peronospora parasitica* (Pers.) de Bary.
- Barbarea Barbarea (L.) McM.
  - *Albugo candida* (Pers.) Rouss.
- Barbarea vulgaris R. Br.; see *B. Barbarea* (L.) McM.
- Brassica alba (L.) Boiss.; see *Sinapis alba* L.
- Brassica arvensis (L.) B.S.P.
  - *Albugo candida* (Pers.) Rouss.
  - *Peronospora parasitica* (Pers.) de Bary.
- Brassica campestris L.
  - *Albugo candida* (Pers.) Rouss.
  - *Peronospora parasitica* (Pers.) de Bary.
- Brassica integrifolia (West) O. E. Schultz.
  - *Albugo candida* (Pers.) Rouss.
- Brassica nigra (L.) Koch.
  - *Albugo candida* (Pers.) Rouss.
  - *Peronospora parasitica* (Pers.) de Bary.
- Brassica oleracea L.
  - *Albugo candida* (Pers.) Rouss.
  - *Peronospora parasitica* (Pers.) de Bary.
- Brassica sativa; see *B. oleracea* L.
- Brassica Sinapistrum Boiss.; see *B. arvensis* (L.) B.S.P.
- Brassica sp.
  - *Albugo candida* (Pers.) Rouss.
  - *Peronospora parasitica* (Pers.) de Bary.
- Bursa Bursa-pastoris (L.) Britton.
  - *Albugo candida* (Pers.) Rouss.
  - *Peronospora parasitica* (Pers.) de Bary.
- Cakile americana Nutt.; see *C. edentula* (Bigel.) Hook.
- Cakile edentula (Bigel.) Hook.
  - *Albugo candida* (Pers.) Rouss.
- Camelina microcarpa Andrz.
  - *Albugo candida* (Pers.) Rouss.
- Camelina sativa (L.) Crantz; see *C. microcarpa* Andrz.
- Capsella Bursa-pastoris (L.) Moench.; see *Bursa Bursa-pastoris* (L.) Britton.
- Cardamine bulbosa (Schreb.) B.S.P.
  - *Albugo candida* (Pers.) Rouss.
  - *Peronospora parasitica* (Pers.) de Bary.
- Cardamine hirsuta (L.).
  - *Peronospora parasitica* (Pers.) de Bary.
- Cardamine laciniata Wood; see *Dentaria laciniata* Muhl.
- Cardamine ludoviciana Hook.; see *Arabis virginica* (L.) Trel.
- Cardamine rhomboidea DC.; see *C. bulbosa* (Schreb.) B.S.P.
- Cheiranthus asper Nutt.
  - *Albugo candida* (Pers.) Rouss.
- Cheiranthus Cheiri L.
  - *Albugo candida* (Pers.) Rouss.
- Cheiranthus pacificum Sheldon.
  - *Albugo candida* (Pers.) Rouss.
- Cochlearia Armoracia L.; see *Roripa Armoracia* (L.) A. S. Hitchcock.
- Cochlearia oleracea; see *Roripa Armoracia* (L.) A. S. Hitchcock.
- Coronopus sp.
  - *Albugo candida* (Pers.) Rouss.
- Dentaria diphylla Michx.
  - *Albugo candida* (Pers.) Rouss.
- Dentaria heterophylla Nutt.
  - *Peronospora parasitica* (Pers.) de Bary.
- Dentaria laciniata Muhl.
  - *Albugo candida* (Pers.) Rouss.
  - *Peronospora parasitica* (Pers.) de Bary.
- Dentaria maxima Nutt.
  - *Peronospora parasitica* (Pers.) de Bary.

Dentaria sp.
*Peronospora parasitica* (Pers.) de Bary.
Draba caroliniana Walt.
*Albugo candida* (Pers.) Rouss.
*Peronospora parasitica* (Pers.) de Bary.
Hesperis matronalis L.
*Albugo candida* (Pers.) Rouss.
*Peronospora parasitica* (Pers.) de Bary.
Iodanthus pinnatifidus (Michx.) Steud.
*Albugo candida* (Pers.) Rouss.
*Peronospora parasitica* (Pers.) de Bary.
Koniga maritima (L.) R. Br.
*Peronospora parasitica* (Pers.) de Bary.
Lepidium campestre (L.) R. Br.
*Albugo candida* (Pers.) Rouss.
Lepidium densiflorum Schrad.
*Albugo candida* (Pers.) Rouss.
*Peronospora parasitica* (Pers.) de Bary.
Lepidium incisum; error for *Sisymbrium incisum* Engelm.
Lepidium intermedium A. Gray; see *L. densiflorum* Schrad.
Lepidium sativum L.
*Albugo candida* (Pers.) Rouss.
*Peronospora parasitica* (Pers.) de Bary.
Lepidium virginicum L.
*Albugo candida* (Pers.) Rouss.
*Peronospora parasitica* (Pers.) de Bary.
Lepidium sp.
*Peronospora parasitica* (Pers.) de Bary.
(See also *L. virginicum* L.)
Nasturtium; see *Roripa.*
Neslia paniculata Desv.
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Raphanus sativus L.
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Roripa Armoracia (L.) A. S. Hitchcock.
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*Peronospora parasitica* (Pers.) de Bary.
Roripa hispida (Desv.) Britton.
*Albugo candida* (Pers.) Rouss.
*Peronospora parasitica* (Pers.) de Bary.
Roripa obtusa (Nutt.) Britton.
*Albugo candida* (Pers.) Rouss.
*Peronospora parasitica* (Pers.) de Bary.
Roripa palustris (DC.) Bessey.
*Albugo candida* (Pers.) Rouss.
*Peronospora parasitica* (Pers.) de Bary.
Roripa sessiliflora (Nutt.) A. S. Hitchcock.
*Albugo candida* (Pers.) Rouss.
Roripa sinuata (Nutt.) A. S. Hitchcock.
*Albugo candida* (Pers.) Rouss.
Roripa Walteri (Ell.) Mohr.
*Albugo candida* (Pers.) Rouss.
Schoenocrambe linifolium (Nutt.) Greene.
*Albugo candida* (Pers.) Rouss.
Sinapis alba L.
*Albugo candida* (Pers.) Rouss.
*Peronospora parasitica* (Pers.) de Bary.
Sinapis arvensis L.; see *Brassica arvensis* (L.) B.S.P.
Sisymbrium canescens Nutt.; see *Sophia pinnata* (Walt.) Britton.
Sisymbrium incisum Engelm.; see *Sophia incisa* (Engelm.) Greene.
Sisymbrium officinale (L.) Scop.
*Albugo candida* (Pers.) Rouss.
Sisymbrium sp.
*Peronospora parasitica* (Pers.) de Bary.
Sophia Hartwegiana (Tourn.) Greene.
*Albugo candida* (Pers.) Rouss.
Sophia incisa (Engelm.) Greene.
*Peronospora parasitica* (Pers.) de Bary.
Sophia pinnata (Walt.) Britton.
*Albugo candida* (Pers.) Rouss.
*Peronospora parasitica* (Pers.) de Bary.
Sophia sp.
*Peronospora parasitica* (Pers.) de Bary.
Thelypodium pinnatifidum S. Wats.; see *Iodanthus pinnatifidus* Steud.
Thlaspi glaucum A. Nelson.
*Albugo candida* (Pers.) Rouss.
Thlaspi Nuttallii Rydb.
*Albugo candida* (Pers.) Rouss.

## CAPRIFOLIACEAE

Viburnum acerifolium L.
*Rhysotheca Viburni* (Peck) G. W. Wilson.
Viburnum dentatum L.
*Rhysotheca Viburni* (Peck) G. W. Wilson.
Viburnum nudum L.
*Rhysotheca Viburni* (Peck) G. W. Wilson.
Viburnum Opulus L.
*Rhysotheca Viburni* (Peck) G. W. Wilson.
Viburnum pubescens (Ait.) Pursh.
*Rhysotheca Viburni* (Peck) G. W. Wilson.

## CARDUACEAE

Antennaria plantaginifolia (L.) Rich.
*Albugo Tragopogonis* (DC.) S. F. Gray.
Artemisia biennis Willd.
*Albugo Tragopogonis* (DC.) S. F. Gray.
*Peronospora leptosperma* de Bary.
Artemisia canadensis Michx.
*Albugo Tragopogonis* (DC.) S. F. Gray.
Artemisia ludoviciana Nutt.
*Peronospora leptosperma* de Bary.
*Rhysotheca Halstedii* (Farl.) G. W. Wilson.
Artemisia sp.
*Peronospora leptosperma* de Bary.
Aster Novae-Angliae L.
*Basidiophora entospora* Roze & Cornu.
Aster oblongifolius Nutt.
*Basidiophora entospora* Roze & Cornu.

- Aster sagittifolius Willd.
  - *Basidiophora cntospora* Roze & Cornu.
- Aster sp.
  - *Basidiophora entospora* Roze & Cornu.
- Bidens cernua L.
  - *Rhysotheca Halstedii* (Farl.) G. W. Wilson.
- Bidens chrysanthemoides Michx.; see *B. laevis* (L.) B.S.P.
- Bidens comosa (A. Gray) Wiegand.
  - *Rhysotheca Halstedii* (Farl.) G. W. Wilson.
- Bidens connata Muhl.
  - *Rhysotheca Halstedii* (Farl.) G. W. Wilson.
- Bidens connata comosa A. Gray; see *B. comosa* (A. Gray) Wiegand.
- Bidens frondosa L.
  - *Rhysotheca Halstedii* (Farl.) G. W. Wilson.
- Bidens laevis (L.) B.S.P.
  - *Rhysotheca Halstedii* (Farl.) G. W. Wilson.
- Carduus arvensis (L.) Robs.
  - *Albugo Tragopogonis* (DC.) S. F. Gray.
- Carduus lanceolatus L.
  - *Albugo Tragopogonis* (DC.) S. F. Gray.
- Carduus muticus (Michx.) Pers.
  - *Albugo Tragopogonis* (DC.) S. F. Gray.
- Carduus spinosissimus Walt.
  - *Albugo Tragopogonis* (DC.) S. F. Gray.
- Carduus undulatus Nutt.
  - *Albugo Tragopogonis* (DC.) S. F. Gray.
- Centaurea sp.
  - *Rhysotheca Halstedii* (Farl.) G. W. Wilson.
- Cirsium arvense (L.) Scop.; see *Carduus arvensis* (L.) Robs.
- Cnicus arvensis (L.) Hook.; see *Carduus arvensis* (L.) Robs.
- Cnicus horridulus Pursh; see *Carduus spinosissimus* Walt.
- Cnicus lanceolatus Hoffm.; see *Carduus lanceolatus* L.
- Cnicus muticus (Michx.) Ell.; see *Carduus muticus* (Michx.) Pers.
- Cnicus sp.; see *Carduus muticus* (Michx.) Pers.
- Erechtites hieracifolia (L.) Raf.
  - *Rhysotheca Halstedii* (Farl.) G. W. Wilson.
- Erigeron annuus (L.) Pers.
  - *Rhysotheca Halstedii* (Farl.) G. W. Wilson.
- Erigeron canadensis L.; see *Leptilon canadense* (L.) Britton.
- Erigeron philadelphicus L.
  - *Basidiophora entospora* Roze & Cornu.
- Erigeron ramosus Willd.
  - *Basidiophora entospora* Roze & Cornu.
- Erigeron sp.
  - *Basidiophora entospora* Roze & Cornu.
- Eupatorium ageratoides L.f.
  - *Rhysotheca Halstedii* (Farl.) G. W. Wilson.
- Eupatorium purpureum L.
  - *Rhysotheca Halstedii* (Farl.) G. W. Wilson.
- Gnaphalium purpureum L.
  - *Rhysotheca Halstedii* (Farl.) G. W. Wilson.
- Gnaphalium spathulatum L.
  - *Rhysotheca Halstedii* (Farl.) G. W. Wilson.
- Helianthus annuus L.
  - *Rhysotheca Halstedii* (Farl.) G. W. Wilson.
- Helianthus divaricatus L.
  - *Rhysotheca Halstedii* (Farl.) G. W. Wilson.
- Helianthus doronicoides Lam.
  - *Rhysotheca Halstedii* (Farl.) G. W. Wilson.
- Helianthus grosseserratus Martens.
  - *Rhysotheca Halstedii* (Farl.) G. W. Wilson.
- Helianthus hirsutus Raf.
  - *Rhysotheca Halstedii* (Farl.) G. W. Wilson.
- Helianthus Maximiliani Schrad.
  - *Rhysotheca Halstedii* (Farl.) G. W. Wilson.
- Helianthus occidentalis Riddell.
  - *Rhysotheca Halstedii* (Farl.) G. W. Wilson.
- Helianthus scaberrimus Ell.
  - *Rhysotheca Halstedii* (Farl.) G. W. Wilson.
- Helianthus strumosus L.
  - *Rhysotheca Halstedii* (Farl.) G. W. Wilson.
- Helianthus tracheliifolius Mill.
  - *Rhysotheca Halstedii* (Farl.) G. W. Wilson.
- Helianthus tuberosus L.
  - *Rhysotheca Halstedii* (Farl.) G. W. Wilson.
- Helianthus sp.
  - *Rhysotheca Halstedii* (Farl.) G. W. Wilson.
    (See also *Iva ciliata* Willd.)
- Leptilon canadense (L.) Britton.
  - *Basidiophora entospora* Roze & Cornu.
- Madia sativa Molina.
  - *Rhysotheca Halstedii* (Farl.) G. W. Wilson.
- Matricaria matricarioides (Less.) Porter.
  - *Albugo Tragopogonis* (DC.) S. F. Gray.
- Parthenium integrifolium L.
  - *Albugo Tragopogonis* (DC.) S. F. Gray.

Parthenium repens Eggert.
*Albugo Tragopogonis* (DC.) S. F. Gray.

Rudbeckia fulgida Ait.
*Basidiophora entospora* Roze & Cornu.

Rudbeckia laciniata L.
*Rhysotheca Halstedii* (Farl.) G. W. Wilson.

Rudbeckia triloba L.
*Rhysotheca Halstedii* (Farl.) G. W. Wilson.

Senecio aureus L.
*Albugo Tragopogonis* (DC.) S. F. Gray. (See also *Senecio oblanceolatus* Rydb.)

Senecio aureus croceus A. Gray; see *S. cymbalarioides* Nutt.

Senecio cymbalarioides Nutt.
*Albugo Tragopogonis* (DC.) S. F. Gray.

Senecio Hartianus Heller.
*Albugo Tragopogonis* (DC.) S. F. Gray.

Senecio lugens Rich.
*Albugo Tragopogonis* (DC.) S. F. Gray.

Senecio MacDougalii Heller.
*Albugo Tragopogonis* (DC.) S. F. Gray.

Senecio oblanceolatus Rydb.
*Albugo Tragopogonis* (DC.) S. F. Gray.

Senecio peninsularis Vasey & Rose.
*Albugo Tragopogonis* (DC.) S. F. Gray.

Senecio Serra Hooker.
*Albugo Tragopogonis* (DC.) S. F. Gray.

Senecio Serra integrifolia A. Gray.
*Albugo Tragopogonis* (DC.) S. F. Gray.

Senecio vulgaris L.
*Bremia Lactucae* Regel.

Senecio sp.
*Albugo Tragopogonis* (DC.) S. F. Gray.

Silphium integrifolium Michx.
*Rhysotheca Halstedii* (Farl.) G. W. Wilson.

Silphium laciniatum L.
*Rhysotheca Halstedii* (Farl.) G. W. Wilson.

Silphium perfoliatum L.
*Rhysotheca Halstedii* (Farl.) G. W. Wilson.

Silphium terebinthinaceum Jacq.
*Rhysotheca Halstedii* (Farl.) G. W. Wilson.

Silphium trifoliatum L.
*Rhysotheca Halstedii* (Farl.) G. W. Wilson.

Solidago canadensis L.
*Rhysotheca Halstedii* (Farl.) G. W. Wilson.

Solidago Riddellii Frank.
*Rhysotheca Halstedii* (Farl.) G. W. Wilson.

Solidago rigida L.
*Basidiophora entospora* Roze & Cornu.

Solidago sp.
*Basidiophora entospora* Roze & Cornu.

Vernonia Baldwinii Torr.
*Rhysotheca Halstedii* (Farl.) G. W. Wilson.

Vernonia noveboracensis (L.) Michx.
*Rhysotheca Halstedii* (Farl.) G. W. Wilson.

Verbesina encelioides (Cav.) A. Gray.
*Rhysotheca Halstedii* (Farl.) G. W. Wilson.

## CHENOPODIACEAE

Atriplex hastata L.
*Peronospora effusa* Rabenh.

Beta vulgaris L.
*Albugo? occidentalis* G. W. Wilson.

Blitum capitatum L.
*Albugo occidentalis* G. W. Wilson.

Chenopodium album L.
*Peronospora effusa* Rabenh.

Chenopodium album viride (L.) Moq.
*Peronospora effusa* Rabenh.

Chenopodium hybridum L.
*Peronospora effusa* Rabenh.

Chenopodium leptophyllum (Moq.) Nutt.
*Peronospora effusa* Rabenh.

Chenopodium rubrum L.
*Albugo occidentalis* G. W. Wilson.

Chenopodium sp.
*Peronospora effusa* Rabenh.

Spinacia oleracea L.
*Peronospora effusa* Rabenh.

## CICHORIACEAE

Adopogon Dandelion (L.) Kuntze.
*Bremia Lactucae* Regel.

Agoseris sp.
*Bremia Lactucae* Regel.

Cichorium Intybus L.
*Bremia Lactucae* Regel.

Krigia Dandelion (L.) Nutt.; see *Adopogon Dandelion* (L.) Kuntze.

Lactuca altissima; error for *Nabalus altissimus.*

Lactuca canadensis L.
*Bremia Lactucae* Regel.

Lactuca hirsuta Muhl.
*Bremia Lactucae* Regel.

Lactuca integrifolia Bigel.; see *L. sagittifolia* Ell.

Lactuca leucophaea A. Gray; see *L. spicata* (Lam.) A. S. Hitchcock.

Lactuca ludoviciana (Nutt.) DC.
*Bremia Lactucae* Regel.

Lactuca pulchella (Pursh) DC.
*Bremia Lactucae* Regel.

Lactuca sagittifolia Ell.
*Bremia Lactucae* Regel.

Lactuca sativa L.
*Bremia Lactucae* Regel.

LACTUCA SPICATA (Lam.) A. S. Hitchcock.
*Bremia Lactucae* Regel.
LACTUCA sp.
*Bremia Lactucae* Regel.
MULGEDIUM LEUCOPHAEUM DC.; see *Lactuca spicata* (Lam.) A. S. Hitchcock.
NABALUS ALBUS (L.) Hook.
*Bremia Lactucae* Regel.
NABALUS ALTISSIMUS (L.) Hook.
*Bremia Lactucae* Regel.
PRENANTHES ALTISSIMA L.; see *Nabalus altissimus* (L.) Hook.
SONCHUS ASPER (L.) All.
*Bremia Lactucae* Regel.
SONCHUS sp.
*Bremia Lactucae* Regel.
TRAGOPOGON PORRIFOLIUS L.
*Albugo Tragopogonis* (DC.) S. F. Gray.

## CONVOLVULACEAE

BATATAS EDULIS (L.) Choisy; see *Ipomoea Batatas* (L.) Lam.
CALONYCTION ACULEATUM (L.) House.
*Albugo Ipomoeae-panduranae* (Schwein.) Swingle.
CALYSTEGIA SEPIUM (L.) R. Br.; see *Convolvulus Sepium* L.
CONVOLVULUS BATATAS L.; see *Ipomoea Batatas* (L.) Lam.
CONVOLVULUS INCANUS Vahl.
*Albugo Ipomoeae-panduranae* (Schwein.) Swingle.
CONVOLVULUS MACRORRHIZA; see *Ipomoea pandurata* (L.) Meyer.
CONVOLVULUS SEPIUM L.
*Albugo Ipomoeae-panduranae* (Schwein.) Swingle.
CONVOLVULUS sp.; see *Ipomoea hederacea* L.
CONVOLVULACEAE, gen. et sp. ignot.
*Albugo Ipomoeae-panduranae* (Schwein.) Swingle.
IPOMOEA BATATAS (L.) Lam.
*Albugo Ipomoeae-panduranae* (Schwein.) Swingle.
IPOMOEA CAROLINA (L.) Pursh.
*Albugo Ipomoeae-panduranae* (Schwein.) Swingle.
IPOMOEA COMMUTATA R. & S.; see *I. Carolina* Pursh.
IPOMOEA HEDERACEA (L.) Jacq.
*Albugo Ipomoeae-panduranae* (Schwein.) Swingle.
IPOMOEA INCARNATA Vahl.
*Albugo Ipomoeae-panduranae* (Schwein.) Swingle.
IPOMOEA LACUNOSA L.
*Albugo Ipomoeae-panduranae* (Schwein.) Swingle.
IPOMOEA LEPTOPHYLLA Torr.
*Albugo Ipomoeae-panduranae* (Schwein.) Swingle.
IPOMOEA MEXICANA A. Gray.
*Albugo Ipomoeae-panduranae* (Schwein.) Swingle.
IPOMOEA PANDURATA (L.) Meyer.
*Albugo Ipomoeae-panduranae* (Schwein.) Swingle.
IPOMOEA PES-CAPRAE (L.) Roth.
*Albugo Ipomoeae-panduranae* (Schwein.) Swingle.
IPOMOEA PURPUREA (L.) Lam.
*Albugo Ipomoeae-panduranae* (Schwein.) Swingle.
IPOMOEA TAMNIFOLIA L.; see *Jacquemontia tamnifolia* (L.) Griseb.
IPOMOEA TRICHOCARPA Ell.
*Albugo Ipomoeae-panduranae* (Schwein.) Swingle.
IPOMOEA TRILOBA L.
*Albugo Ipomoeae-panduranae* (Schwein.) Swingle.
JACQUEMONTIA TAMNIFOLIA (L.) Griseb.
*Albugo Ipomoeae-panduranae* (Schwein.) Swingle.
QUAMOCLIT QUAMOCLIT (L.) Britton.
*Albugo Ipomoeae-panduranae* (Schwein.) Swingle.
QUAMOCLIT VULGARIS L.; see *Q. Quamoclit* (L.) Britton.

## CUCURBITACEAE

BRYONOPSIS LACINIOSA ERYTHROCARPA Naud.
*Pseudoperonospora cubensis* (B. & C.) Rostow.
CITRULLUS VULGARIS Schrad.
*Pseudoperonospora cubensis* (B. & C.) Rostow.
COCCINIA INDICA Wight & Arn.
*Pseudoperonospora cubensis* (B. & C.) Rostow.
CUCUMIS ANGURIA L.
*Pseudoperonospora cubensis* (B. & C.) Rostow.
CUCUMIS ANGULATUS Forsk.
*Pseudoperonospora cubensis* (B. & C.) Rostow.
CUCUMIS DIPSACEUS Ehrenb.
*Pseudoperonospora cubensis* (B. & C.) Rostow.
CUCUMIS ERINACEUS; horticultural name for *C. dipsaceus* Ehrenb.
CUCUMIS MELO L.
*Pseudoperonospora cubensis* (B. & C.) Rostow.
CUCUMIS ODORATISSIMUS Moench.
*Pseudoperonospora cubensis* (B. & C.) Rostow.
CUCUMIS SATIVUS L.
*Pseudoperonospora cubensis* (B. & C.) Rostow.

Cucurbita maxima Duch.
*Pseudoperonospora cubensis* (B. & C.) Rostow.

Cucurbita esculenta S. F. Gray; see *Cucurbita Pepo* L.

Cucurbita ovifera L.
*Pseudoperonospora cubensis* (B. & C.) Rostow.

Cucurbita Pepo L.
*Pseudoperonospora cubensis* (B. & C.) Rostow.

Cucurbita verrucosa L.; see *C. Pepo* L.

Cucurbitaceae, gen. et sp. ignot.
*Pseudoperonospora cubensis* (B. & C.) Rostow.

Echinocystis lobata (Michx.) T. & G.; see *Micrampelis lobata* (Michx.) A. Gray.

Lagenaria vulgaris Ser.
*Pseudoperonospora cubensis* (B. & C.) Rostow.

Melothria scabra Naud.
*Pseudoperonospora cubensis* (B. & C.) Rostow.

Micrampelis echinata (Muhl.) B.S.P.; see *M. lobata* (Michx.) A. Gray.

Micrampelis lobata (Michx.) A. Gray.
*Pseudoperonospora cubensis* (B. & C.) Rostow.
*Rhysotheca australis* (Speg.) G. W. Wilson.

Momordica Balsamina L.
*Pseudoperonospora cubensis* (B. & C.) Rostow.

Momordica Charantia L.
*Pseudoperonospora cubensis* (B. & C.) Rostow.

Mukia scabrella Arn.
*Pseudoperonospora cubensis* (B. & C.) Rostow.

Sicyos angulatus L.
*Rhysotheca australis* (Speg.) G. W. Wilson.

Trichosanthes Anguina L.
*Pseudoperonospora cubensis* (B. & C.) Rostow.

Trichosanthes columbrina Jacq.; see *T. Anguina* L.

### DIPSACEAE

Dipsacus sylvestris Huds.
*Peronospora Dipsaci* Tul.

### EUPHORBIACEAE

Chamaesyce cordifolia (Ell.) Small.
*Peronospora Euphorbiae* Fuckel.

Chamaesyce glyptosperma (Engelm.) Small.
*Peronospora Euphorbiae* Fuckel.

Chamaesyce hirtula (Engelm.) Small.
*Peronospora Euphorbiae* Fuckel.

Chamaesyce humistrata (Engelm.) Small.
*Peronospora Euphorbiae* Fuckel.

Chamaesyce maculata (L.) Small.
*Peronospora Euphorbiae* Fuckel.

Chamaesyce nutans (Lag.) Small.
*Peronospora Euphorbiae* Fuckel.

Chamaesyce serpens (H.B.K.) Small.
*Peronospora Euphorbiae* Fuckel.

Chamaesyce serpyllifolia (Pers.) Small.
*Peronospora Euphorbiae* Fuckel.

Chamaesyce stictospora (Engelm.) Small.
*Peronospora Euphorbiae* Fuckel.

Euphorbia; see *Chamaesyce.*

Euphorbia hirsuta Engelm.; error for *E. hirtula* Engelm.

Euphorbia hypericifolia A. Gray; see *Chamaesyce nutans* (Lag.) Small.

Euphorbia Preslii Guss.; see *Chamaesyce nutans* (Lag.) Small.

### FABACEAE

Astragalus canadensis L.
*Peronospora Trifoliorum* de Bary.

Astragalus lotiflorus Hook.
*Peronospora Trifoliorum* de Bary.

Astragalus sp.
*Peronospora Trifoliorum* de Bary.

Medicago sativa L.
*Peronospora Trifoliorum* de Bary.

Phaseolus lunatus L.
*Phytophthora Phaseoli* Thaxter.

Pisum sativum L.
*Peronospora Viciae* de Bary.

Trifolium carolinianum Michx.
*Peronospora Trifoliorum* de Bary.

Trifolium sp.
*Peronospora Trifoliorum* de Bary.

Vicia americana Muhl.
*Peronospora Viciae* de Bary.

Vicia americana linearis S. Wats.; see *V. linearis* (Nutt.) Greene.

Vicia Faba L.
*Peronospora Viciae* de Bary.

Vicia linearis (Nutt.) Greene.
*Peronospora Viciae* de Bary.

Vicia sativa L.
*Peronospora Viciae* de Bary.

Vicia sp.
*Peronospora Viciae* de Bary.

### FUMARIACEAE

Bicuculla canadensis (Goldie) Millsp.
*Peronospora Corydalis* de Bary.

Bicuculla Cucullaria (L.) Millsp.
*Peronospora Corydalis* de Bary.

Bicuculla sp.
*Peronospora Corydalis* de Bary.

Capnoides aureum (Willd.) Kuntze.
*Peronospora Corydalis* de Bary.

Capnoides sempervirens (L.) Borck.
*Peronospora Corydalis* de Bary.

CAPNOIDES sp.
*Peronospora Corydalis* de Bary.
CORYDALIS; see *Capnoides.*
CORYDALIS AUREA OCCIDENTALIS Engelm.; see *Capnoides aureum* (Willd.) Kuntze.
CORYDALIS GLAUCA Pursh; see *Capnoides sempervirens* (L.) Borck.
DICENTRA; see *Bicuculla.*

## GERANIACEAE

GERANIUM CAROLINIANUM L.
*Rhysotheca Geranii* (Peck) G. W. Wilson.
GERANIUM DISSECTUM L.
*Rhysotheca Geranii* (Peck) G. W. Wilson.
GERANIUM MACULATUM L.
*Rhysotheca Geranii* (Peck) G. W. Wilson.
GERANIUM PUSILLUM Burm. f.
*Rhysotheca Geranii* (Peck) G. W. Wilson.
GERANIUM RICHARDSONII Fish. & Trautv.
*Rhysotheca Geranii* (Peck) G. W. Wilson.
GERANIUM ROBERTIANUM L.
*Rhysotheca Geranii* (Peck) G. W. Wilson.
GERANIUM sp.
*Rhysotheca Geranii* (Peck) G. W. Wilson.

## GROSSULARIACEAE

GROSSULARIA DIVARICATA (Dougl.) Coville & Britton.
*Rhysotheca ribicola* (Schröt.) G. W. Wilson.
GROSSULARIA OXYACANTHOIDES (L.) Mill.
*Rhysotheca ribicola* (Schröt.) G. W. Wilson.
GROSSULARIA ROTUNDIFOLIA (Michx.) Coville & Britton.
*Rhysotheca ribicola* (Schröt.) G. W. Wilson.
RIBES ALBINERVUM Michx.; see *R. triste* Pall.
RIBES DIVARICATUM Dougl.; see *Grossularia divaricata* (Dougl.) Coville & Britton.
RIBES GLANDULOSUM Grauer.
*Rhysotheca ribicola* (Schröt.) G. W. Wilson.
RIBES HIRTELLUM Michx.; see *Grossularia oxyacanthoides* (L.) Mill.
RIBES OXYACANTHOIDES L.; see *Grossularia oxyacanthoides* (L.) Mill.
RIBES PROSTRATUM L'Hér.; see *R. glandulosum* Grauer.
RIBES ROTUNDIFOLIUM Michx.; see *Grossularia rotundifolia* (Michx.) Coville & Britton.
RIBES RUBRUM SUBGLANDULOSUM Maxim.; see *R. triste* Pall.
RIBES TRISTE Pall.
*Rhysotheca ribicola* (Schröt.) G. W. Wilson.

## HYDROPHYLLACEAE

HYDROPHYLLUM MACROPHYLLUM Nutt.
*Peronospora Hydrophylli* Waite.
HYDROPHYLLUM VIRGINICUM L.
*Peronospora Hydrophylli* Waite.

## LAMIACEAE

AGASTACHE NEPETOIDES (L.) Kuntze.
*Peronospora Lophanthi* Farlow.
AGASTACHE SCROPHULARIAEFOLIA (Willd.) Kuntze.
*Peronospora Lophanthi* Farlow.
HEDEOMA HISPIDA Pursh.
*Peronospora Hedeomae* K. & S.
LAMIUM AMPLEXICAULE L.
*Peronospora Lamii* A. Braun.
LOPHANTHUS; see *Agastache.*
SALVIA LANCEOLATA Willd.
*Peronospora Lamii* A. Braun.

## LIMNANTHACEAE

FLOERKEA PROSERPINACOIDES Willd.
*Peronospora Floerkeae* Kellerm.

## LINACEAE

LINUM SULCATUM Ridd.
*Peronospora Lini* Schröt.

## ONAGRACEAE

GAURA PARVIFLORA Dougl.
*Peronospora Arthurii* Farl.
HARTMANNIA SPECIOSA (Nutt.) Small.
*Peronospora Arthurii* Farl.
MEGAPTERIUM MISSOURIENSE (Sims) Spach.
*Peronospora Arthurii* Farl.
OENOTHERA BIENNIS L.; see *Onagra biennis* (L.) Scop.
OENOTHERA LACINIATA Hill.
*Peronospora Arthurii* Farl.
OENOTHERA MISSOURIENSIS Sims; see *Megapterium missouriense* Spach.
OENOTHERA SINUATA L.; see *O. laciniata* Hill.
OENOTHERA SPECIOSA Nutt.; see *Hartmannia speciosa* (Nutt.) Small.
OENOTHERA sp.
*Peronospora Arthurii* Farl.
ONAGRA BIENNIS (L.) Scop.
*Peronospora Arthurii* Farl.

## PAPAVERACEAE

ARGEMONE PLATYCERAS Coulter.
*Peronospora arborescens* (Berk.) de Bary.

## PLANTAGINACEAE

PLANTAGO ARISTATA Michx.
*Peronospora plantaginis* Underw.
PLANTAGO LANCEOLATA L.
*Peronospora alta* Fuckel.
PLANTAGO MAJOR L.
*Peronospora alta* Fuckel.
PLANTAGO PATAGONICA ARISTATA (Michx.) A. Gray; see *P. aristata* Michx.
PLANTAGO RUGELII Decaisne.
*Peronospora alta* Fuckel.
PLANTAGO VIRGINICA L.
*Peronospora alta* Fuckel.
PLANTAGO sp.
*Peronospora alta* Fuckel.

## POACEAE.

CHAETOCHLOA GLAUCA (L.) Scribn.
*Sclerospora graminicola* (Sacc.) Schröt.
CHAETOCHLOA ITALICA (L.) Scribn.
*Sclerospora graminicola* (Sacc.) Schröt.
CHAETOCHLOA VIRIDIS (L.) Scribn.
*Sclerospora graminicola* (Sacc.) Schröt.
CHAMAERAPHIS; see *Chaetochloa.*
CHLORIS ELEGANS H.B.K.
*Sclerospora Farlowii* Griff.
IXOPHORUS; see *Chaetochloa.*
SETARIA; see *Chaetochloa.*

## POLEMONIACEAE

GILIA sp.
*Peronospora Giliae* E. & E.
PHLOX DIVARICATA L.
*Peronospora phlogina* D. & H.

## POLYGONACEAE

POLYGONUM AVICULARE L.
*Peronospora Polygoni* Thümen.
POLYGONUM DUMETORUM L.; see *Tiniaria dumetorum* (L.) Opiz.
POLYGONUM DUMETORUM SCANDENS (L.) A. Gray; see *Tiniaria scandens* (L.) Small.
TINIARIA DUMETORUM (L.) Opiz.
*Peronospora Polygoni* Thümen.
TINIARIA SCANDENS (L.) Small.
*Peronospora Polygoni* Thümen.

## PORTULACACEAE

CALANDRINIA MENZIESII Hook.
*Peronospora Claytoniae* Farl.
CLAYTONIA PERFOLIATA Donn; see *Montia perfoliata* (Donn) Howell.
CLAYTONIA VIRGINICA L.
*Peronospora Claytoniae* Farl.
MONTIA PERFOLIATA (Donn) Howell.
*Peronospora Claytoniae* Farl.
PORTULACA OLERACEA L.
*Albugo Portulacae* (DC.) Kuntze.

## PRIMULACEAE

ANDROSACE OFFICINALIS Pursh.
*Peronospora candida* Fuckel.

## RANUNCULACEAE

ANEMONE ACUTILOBA Laws.; see *Hepatica acutiloba* (Pursh) Britton.
ANEMONE CANADENSIS L.
*Plasmopara pygmaea* (Unger) Schröt.
ANEMONE DICHOTOMA L.; see *A. canadensis* L.
ANEMONE MULTIFIDA Poir.
*Plasmopara pygmaea* (Unger) Schröt.
ANEMONE NEMOROSA L.; see *A. quinquefolia* L.
ANEMONE PENNSYLVANICA L.; see *A. canadensis* L.
ANEMONE QUINQUEFOLIA L.
*Plasmopara pygmaea* (Unger) Schröt.
ANEMONE VIRGINIANA L.
*Plasmopara pygmaea* (Unger) Schröt.
ANEMONE sp.
*Plasmopara pygmaea* (Unger) Schröt.
HEPATICA ACUTA (Pursh) Britton.
*Plasmopara pygmaea* (Unger) Schröt.
HEPATICA ACUTILOBA DC.; see *H. acuta* (Pursh) Britton.
HEPATICA HEPATICA (L.) Karst.
*Plasmopara pygmaea* (Unger) Schröt.
HEPATICA TRILOBA Chaix; see *H. Hepatica* (L.) Karst.
RANUNCULUS ABORTIVUS L.
*Peronospora Ficariae* Tul.
RANUNCULUS ACRIS Tul.
*Peronospora Ficariae* Tul.
RANUNCULUS BULBOSUS L.
*Peronospora Ficariae* Tul.
RANUNCULUS FASCICULARIS Muhl.
*Peronospora Ficariae* Tul.
RANUNCULUS PENNSYLVANICUS L. f.
*Peronospora Ficariae* Tul.
RANUNCULUS RECURVATUS Poir.
*Peronospora Ficariae* Tul.
RANUNCULUS REPENS L.
*Peronospora Ficariae* Tul.
RANUNCULUS SEPTENTRIONALIS Poir.
*Peronospora Ficariae* Tul.
RANUNCULUS sp.
*Peronospora Ficariae* Tul.
THALICTRUM PURPURASCENS L.
*Phytophthora Thalictri* Wilson & Davis.

## ROSACEAE

AGRIMONIA EUPATORIA L.; see *A. mollis* (T. & G.) Britton.
AGRIMONIA MOLLIS (T. & G.) Britton.
*Peronospora Potentillae* de Bary.
GEUM ALBUM Gmel.; see *G. canadense* Jacq.
GEUM CANADENSE Jacq.
*Peronospora Potentillae* de Bary.

Geum macrophyllum Willd.
*Peronospora Potentillae* de Bary.
Geum rivale L.
*Peronospora Potentillae* de Bary.
Potentilla grandiflora L.
*Peronospora Potentillae* de Bary.
Potentilla monspeliensis L.
*Peronospora Potentillae* de Bary.
Potentilla norvegica L.; see *P. monspeliensis* L.
Potentilla nepalensis Hook.
*Peronospora Potentillae* de Bary.
Potentilla sp.
*Peronospora Potentillae* de Bary.
Rosa californica Schlecht.
*Peronospora sparsa* Berk.
Rosa sp.
*Peronospora sparsa* Berk.
Rubus Baileyanus Britton.
*Peronospora Rubi* Rabenh.
Rubus canadensis L.; see *R. procumbens* Muhl.
Rubus nigrobaccus Bailey.
*Peronospora Rubi* Rabenh.
Rubus occidentalis L.
*Peronospora Rubi* Rabenh.
Rubus procumbens Muhl.
*Peronospora Rubi* Rabenh.
Rubus strigosus Michx.
*Peronospora Rubi* Rabenh.
Rubus villosus Ait.; see *R. nigrobaccus* Bailey.
Rubus villosus humifusus T. & G.; see *R. Baileyanus* Britton.
Rubus sp.
*Peronospora Rubi* Rabenh.

## RUBIACEAE

Galium Aparine L.
*Peronospora calotheca* de Bary.
Galium boreale L.
*Peronospora calotheca* de Bary.
Galium lanceolatum Torr.
*Peronospora calotheca* de Bary.
Galium triflorum Michx.
*Peronospora calotheca* de Bary.
Galium sp.
*Peronospora calotheca* de Bary.
Houstonia minor (Michx.) Britton.
*Peronospora Seymourii* Burrill.
Houstonia patens Ell.; see *H. minor* (Michx.) Britton.

## SAXIFRAGACEAE

Whipplea modesta Torr.
*Peronospora Whippleae* E. & E.

## SCROPHULARIACEAE

Linaria canadensis (L.) Dumont.
*Peronospora Linariae* Fuckel.
Scrophularia californica Cham.
*Peronospora sordida* B. & Br.
Scrophularia marilandica L.
*Peronospora sordida* B. & Br.
Scrophularia nodosa L.; see *S. marilandica* L.
Scrophularia nodosa marilandica A. Gray; see *S. marilandica* L.
Scrophularia sp.
*Peronospora sordida* B. & Br.
Veronica alpina L.; see *V. Wormskioldii* R. & S.
Veronica Anagallis L.; see *V. Anagallis-aquatica* L.
Veronica Anagallis-aquatica L.
*Peronospora grisea* Unger.
Veronica arvensis L.
*Peronospora grisea* Unger.
Veronica peregrina L.
*Peronospora grisea* Unger.
Veronica Wormskioldii R. & S.
*Peronospora grisea* Unger.
Veronica sp.
*Peronospora grisea* Unger.

## SOLANACEAE

Lycopersicon Lycopersicon (L.) Karst.
*Phytophthora infestans* (Mont.) de Bary.
Nicotiana glauca Graham.
*Peronospora Nicotianae* Speg.
Solanum Lycopersicon L.; see *Lycopersicon Lycopersicon* (L.) Karst.
Solanum tuberosum L.
*Phytophthora infestans* (Mont.) de Bary.

## STERCULIACEAE

Theobroma Cacao L.
*Phytophthora Cactorum* (C. & L.) Schröt.

## ULMACEAE

Celtis occidentalis L.
*Pseudoperonospora Celtidis* (Waite) G. W. Wilson.

## URTICACEAE

Laportea canadensis Gaud.; see *Urticastrum divaricatum* (L.) Kuntze.
Parietaria pennsylvanica Muhl.
*Rhysotheca illinoiensis* Farlow.
Urtica gracilis Ait.
*Peronospora Urticae* de Bary.
Urtica sp.
*Peronospora Urticae* de Bary.
Urticastrum divaricatum (L.) Kuntze.
*Peronospora Urticae* de Bary.

## VIOLACEAE

Viola odorata L.
*Peronospora Violae* de Bary.
Viola Rafinesquii Greene.
*Peronospora Violae* de Bary.
Viola tenella Muhl.; see *V. Rafinesquii* Greene.
Viola tricolor L.
*Peronospora Violae* de Bary.
Viola tricolor arvensis Hook.; see *V. Rafinesquii* Greene.

## VITACEAE

Ampelopsis quinquefolia (L.) Michx.; see *Parthenocissus quinquefolia* (L.) *Planch.*
Ampelopsis Richii; error for *A. Veitchii.*
Ampelopsis Veitchii; horticultural name for *Parthenocissus tricuspidata* (Sieb. & Zucc.) Planch.
Parthenocissus quinquefolia (L.) Planch.
*Rhysotheca viticola* (B. & C.) G. W. Wilson.
Parthenocissus tricuspidata (Sieb. & Zucc.) Planch.
*Rhysotheca viticola* (B. & C.) G. W. Wilson.
Vitis aestivalis Michx.
*Rhysotheca viticola* (B. & C.) G. W. Wilson.
Vitis bicolor LeConte.
*Rhysotheca viticola* (B. & C.) G. W. Wilson.
Vitis californica Hook. & Arn.
*Rhysotheca viticola* (B. & C.) G. W. Wilson.
Vitis cinerea Engelm.
*Rhysotheca viticola* (B. & C.) G. W. Wilson.
Vitis cordifolia Michx.
*Rhysotheca viticola* (B. & C.) G. W. Wilson.
Vitis Labrusca L.
*Rhysotheca viticola* (B. & C.) G. W. Wilson.
Vitis riparia L.; see *V. vulpina* L.
Vitis rotundifolia Michx.
*Rhysotheca viticola* (B. & C.) G. W. Wilson.
Vitis vinifera L.
*Rhysotheca viticola* (B. & C.) G. W. Wilson.
Vitis vulpina L.
*Rhysotheca viticola* (B. & C.) G. W. Wilson.
Vitis sp.
*Rhysotheca viticola* (B. & C.) G. W. Wilson.

New York Botanical Garden.

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# STUDIES OF WEST INDIAN PLANTS—II

By NATHANIEL LORD BRITTON

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# Studies of West Indian plants — II

NATHANIEL LORD BRITTON

## 7. HARRISIA, A NEW GENUS OF CACTACEAE

Night-flowering cacti with slender upright branched cylindric stems, the branches fluted, with from 8 to 11 rounded ribs, separated by shallow grooves and bearing areoles at frequent intervals, each areole with several acicular spines. Flowers borne singly, at areoles near the ends of the branches, funnelform, large, with a cylindric scaly but spineless tube as long as the limb or longer; buds globose, ovoid or obovoid, densely scaled, the scales bearing long or short woolly hairs; sepals pink or greenish, linear-lanceolate; petals white; stamens shorter than the petals, style somewhat longer than the stamens; fruit globose to ovoid-globose, green to yellow, spineless but with deciduous scales, the corolla withering-persistent; seeds very numerous, small.

The genus is named in honor of William Harris, Superintendent of Public Gardens and Plantations of Jamaica, distinguished for his contributions to the knowledge of the flora of that island. The descriptions are drawn up mainly from field observations and from living plants in the collections of the New York Botanical Garden.

- Bud-scales densely covered with hairs 1–1.5 cm. long.
  - Hairs bright white; areoles 2.5–3 cm. apart; spines 6–9, the longer 2.5–3 cm. long. 1. *H. eriophorus.*
  - Hairs tawny; areoles 2–2.5 cm. apart; spines 8–11, the longer 1 cm. long. 2. *H. Fernowi.*
- Bud-scales loosely covered with hairs 3–10 mm. long.
  - Buds rounded-truncate. 3. *H. portoricensis.*
  - Buds pointed.
    - Plant dark green; hairs of the bud-scales straight. 4. *H. gracilis.*
    - Plants light green; hairs of the bud scales curled.

Spines 3–6, the longer 1.5 mm. long; buds obovoid, very short-pointed. 5. *H. Nashii.*
Spines 9–15; buds ovoid to subglobose.
  Areoles 1 cm. apart; spines 1 cm. long. 6. *H. undata.*
  Areoles 2–3 cm. apart; longer spines 2–5 cm. long.
    Buds ovoid, long-pointed; longer spines 2.5 cm. long. 7. *H. Brookii.*
    Buds subglobose, short-pointed; longer spines 4–5 cm. 8. *H. Taylori.*

### 1. **Harrisia eriophora** (Pfeiff.)

*Cereus cubensis* Zucc.; Seitz, Allg. Gartenz. **2**: 244. 1834. [Hyponym.]

*Cereus eriophorus* Pfeiff. Enum. 94. 1837.

Plant rather light green, the main stem 4 cm. in diameter or more, the branches nearly as thick, erect-ascending, 8-ribbed or 9-ribbed, the ribs prominent, the depressions between them rather deep. Areoles 3–4 cm. apart; spines 6–9, the longer ones 2.5–4 cm. long, light brown with nearly black tips; buds ovoid, sharp-pointed, their scales densely covered with bright white woolly hairs 1–1.5 cm. long; flower about 18 cm. long; scales of the tube lanceolate, acuminate, appressed, 1–1.5 cm. long, bearing long white hairs; sepals pale pink outside, the outer greenish; petals pure white, tipped with a hair-like cusp 5 mm. long; filaments white; anthers oblong, yellow; pistil cream-colored.

Description from N. Y. B. G. *no. 28933*, collected by C. F. Baker at Cajimar, Cuba, in 1907.

Type locality: Cuba.

Distribution: Cuba.

Illustration: Pfeiff. & Otto, Abb. u. Beschr. Cact. *pl. 22.*

### 2. **Harrisia Fernowi** sp. nov.

Plant 2.5–3 m. high; branches slender, about 2.5 cm. thick, light green, 9-ribbed, the ribs not prominent, the depressions between them shallow. Areoles about 2 cm. apart; spines 8–11, light brown with blackish tips, the longer ones 1 cm. long; bud subglobose-ovoid, its scales rather densely covered with tawny curled woolly hairs 1 cm. long; flower nearly 2 dm. long.

*Cereus pellucidus* Griseb. Cat. Pl. Cub. 116. 1866. Not *C. pellucidus* Otto. 1837.

Description mainly from N. Y. B. G. *no. 25766*, collected by Norman Taylor (*no. 254*), between Rio Grande and Rio Ubero, in eastern Cuba in company with Prof. B. E. Fernow, in 1906; collected also by C. Wright, near Guantanamo.

### 3. **Harrisia portoricensis** sp. nov.

Plant slender, 2–3 m. high, little branched, the branches 3–4 cm. thick, 11-ribbed, the ribs rounded, the depressions between them shallow. Areoles 1.5–2 cm. apart; spines 13–17, grayish white to brown with dark tips, the longer ones 2.5–3 cm. long; bud obovoid, depressed-truncate, its scales with many curled white hairs 6 mm. long or less; flower about 1.5 dm. long; sepals pinkish green inside; scales of the corolla-tube lanceolate, appressed, 1.5 cm. long, loosely hairy, the hair completely deciduous in flakes; fruit ovoid, yellow, tubercled, acuminate at the apex, rounded at the base, 4 cm. long, 3 cm. in diameter.

Description from N. Y. B. G. *no. 24653*, collected by N. L. Britton and John F. Cowell, near Ponce, Porto Rico (*no. 1324*), in 1906.

### 4. **Harrisia gracilis** (Mill.)

*Cereus gracilis* Mill. Gard. Dict. ed. 8, no. 8. 1768.

*Cereus repandus* Haw. Syn. Pl. Succ. 183. 1812. Not *Cereus repandus* L.

? *Cereus subrepandus* Haw. Suppl. Pl. Succ. 78. 1819.

Plant much branched, often 7 m. high, dark green, its branches rather slender, somewhat divergent, 9–11-ribbed, the ribs rounded, the depression between them rather shallow. Areoles 1.5–2 cm. apart; spines 10–16, whitish with black tips, the longer 2–2.5 cm. long; bud oblong-ovoid, short-pointed, its scales with a few straight white hairs 8–12 mm. long; corolla 2 dm. long, the scales of its tube greenish brown, narrowly lanceolate, abruptly bent upward near the base, acuminate, about 2 cm. long, having a few hairs, the sepals pale brown, the petals white; fruit depressed globose, yellow, about 5 cm. long, 6–7 cm. thick, the base flat, the top bluntly pointed, strongly tubercled when young, the tubercles low-conic, about 4 mm. high, about 1.5 cm. from tip to tip, bearing a deciduous triangular-lanceolate scale 6–8 mm. long, becoming confluent, the fruit finally smooth or nearly so.

Description from N. Y. B. G. *no. 21902*, collected in Jamaica by Mr. John F. Cowell in 1904, and from *Britton 1255*, Great Pedro Bay, Jamaica. This plant has been observed by me in great quantities in the arid districts of the southern part of Jamaica, and is represented in our collections by living specimens from six localities. I designate this species as the type of the genus.

TYPE LOCALITY: British Islands of America.

DISTRIBUTION: Jamaica.

*Harrisia gracilis* has been illustrated as follows: Trew, Pl. Select. *pl. 14;* Bot. Reg. *pl. 336*, as *Cactus repandus;* DC. Mém. Mus. Paris **17**: *pl. 3*, as *Cereus repandus.*

### 5. **Harrisia Nashii** sp. nov.

Branches widely divergent, light green, 3–4 cm. thick, 9–11-ribbed, the ribs rounded. Areoles 2–2.5 cm. apart; spines only 3–6, gray, the longer ones 15 mm. long; bud narrowly obovoid, obtuse, very short-pointed, its scales with many curled white hairs 6 mm. long or less; corolla 1.6 dm. long; scales of the corolla-tube linear, acuminate, 1.5 cm. long, bearing a few hairs; fruit ellipsoid, 6–8 cm. long. 4–5 cm. thick, very strongly tubercled, the conic tubercles 6–8 mm. high.

Description from N. Y. B. G. *no. 24089*, collected between Gonaives and Plaisance in Haiti by G. V. Nash and Norman Taylor (*no. 1765*), in 1905.

ILLUSTRATION: ? Descour. Fl. Med. Ant. **1**: *pl. 66*, as *Cactus divaricatus.*

### 6. **Harrisia undata** (Pfeiff.)

*Cereus undatus* Pfeiff. Enum. Cact. 94. 1837.

Plant branched, about 2 m. high, the older branches light green, 10-ribbed, the ribs rounded, the depressions between them shallow; young branches dark green, only about 2 cm. thick. Areoles only 1 cm. apart; spines 12–15, gray, the longer ones only 1 cm. long; bud small, ovoid, short-pointed, its scales with few somewhat curled hairs 4–6 mm. long; flower (according to Pfeiffer and Otto) about 1.5 dm. long, the tube green, covered with acute loosely woolly scales, the petals white, denticulate.

Description from N. Y. B. G. *no. 19263*, obtained by N. L. Britton from the Havana Botanic Garden in 1903 (*no. 502*), and determined as *Cereus undatus* Pfeiff. by the description.

DISTRIBUTION: Cuba.

ILLUSTRATION: Pfeiff. & Otto, Abb. u. Beschr. Cact. *pl. 23*, which shows the areoles farther apart than they are in our living plants.

### 7. **Harrisia Brookii** sp. nov.

Plant 5 m. high, much branched, light green; branches 3–4 cm. thick, 10-ribbed, the ribs very prominent, with deep depressions between them. Areoles about 2 cm. apart; spines 9–12, the longer ones 2–2.5 cm. long; bud ovoid, prominently long-pointed, its scales with few curled white hairs 7-10 mm. long; fruit yellowish, ellipsoid, about 8 cm. long, 5–6 cm. thick, rounded at both ends, the tubercles very low, with tips only 1.5 mm. high.

Description from N. Y. B. G. *no. 2614*, collected at Georgetown, Long Island, Bahamas, by N. L. Britton and C. F. Millspaugh, in 1907 (*no. 6337*). Named in honor of Hon. Herbert A. Brook, Registrar of the Bahamas, in recognition of his valuable aid in our exploration of these islands.

The plant of Florida, of which I do not yet know the buds or the flowers, more closely resembles this Bahamian species in its spines and areoles than it does any of the others here described. Our living plant, N. Y. B. G. *no. 19900*, was collected by Prof. P. H. Rolfs on islands east of Malabar and brought to the Garden by Dr. J. K. Small in 1903. As shown by an herbarium specimen, prepared by Dr. Small at that time (*no. 78*), the fruit of this species is nearly globular, about 5 cm. in diameter, and apparently smooth or nearly so. We also have an excellent photograph, taken by Mr. C. L. Pollard on Key Largo; and Curtiss' N. A. Plants *no. 963*, from a locality between the Indian River and the ocean, is this same species, which is described in Chapman's Southern Flora, at least in so far as the flower is concerned, under the name *Cereus monoclonos*, but it is not *C. monoclonos* of De Candolle.

### 8. **Harrisia Taylori** sp. nov.

Plant light green, branched above, 1.5–2 m. high, the branches divaricate-ascending, rather stout, 4 or 5 cm. thick, 9-ribbed, the ribs rounded, the depressions between them rather deep. Areoles 2–3 cm. apart; spines 9–12, the longer 3–5 cm. long, ascending; bud globose-ovoid, short-pointed, its scales with sparse curled grayish-white wool 3–6 mm. long.

Description from N. Y. B. G. *no. 25767*, collected by Norman Taylor on the sea-beach between Rio Grande and Rio Ubero, in in eastern Cuba, in 1906 (*no. 253*).

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### 9? CEREUS DIVARICATUS Lam. Encycl. **1**: 540. 1783.

*Cereus divergens* Pfeiff. Enum. 95. 1837.

*Pilocereus divaricatus* Lemaire, Rev. Hort. **1862**: 427. 1862.

TYPE LOCALITY: Santo Domingo.

DISTRIBUTION: Santo Domingo and Haiti.

ILLUSTRATION: Plumier, Pl. Amer. ed. Burmann, *pl. 193*.

Known only from Plumier's description and illustration; it may belong to the genus *Harrisia*, — although the long-exserted style seems to preclude it.

10? CEREUS ERECTUS Karw.; Pfeiff. Enum. 95. 1837.

TYPE LOCALITY: Mexico.

Referred in synonymy by Schumann to *Cereus repandus*, that is to say, presumably a *Harrisia*. Known only from the description.

*Cereus repandus* L., originally from Curaçao, is, from the description, presumably a *Cephalocereus*.

## 8. POTOMORPHE PELTATA (L.) MIQ.

POTOMORPHE PELTATA (L.) Miq. Comm. Phyt. 37. 1838.
*Piper peltatum* L. Sp. Pl. 30. 1753.
*Piper umbellatum* L. Sp. Pl. 30. 1753.
*Potomorphe umbellata* Miq. Comm. Phyt. 31. 1838.

Field observations in Jamaica demonstrate that the two supposed species of *Potomorphe* are not distinct. The difference of peltate and non-peltate leaves depended upon by Linnaeus and most subsequent authors who have had occasion to describe these plants, including M. Casimir de Candolle (in Urban, Symb. Ant. **3**: 208–211), is worthless, because individual plants bear both kinds of leaves. I had long suspected this to be the case, and while discussing the matter with Mr. William Harris on the road from Bath to Cuna Cuna Gap last September, where specimens of both supposed species were abundant, he almost immediately detected a plant which bore peltate leaves at its upper nodes and non-peltate leaves at the lower ones, and we found a plenty of such specimens afterwards (*Britton 3513*). The relative number of spikes, which also has been supposed to differentiate the species, I had previously found to be quite inconstant, and the character of pubescence used in the descriptions by M. de Candolle is also inconstant, as evidenced by his proposing a hairy variety of *P. peltata* (*loc. cit.* 210, as *Piper peltatum hirtellum* C. DC.).

M. de Candolle includes the species in the genus *Piper*, and describes them as shrubs up to 4 meters high. As a matter of fact, the plant is not properly a shrub, its stems being soft, not appreciably woody; his principal character to distinguish *Piper* from *Peperomia* is that *Piper* consists of shrubs and trees and *Peperomia* of herbs; *P. peltata* should then be excluded from *Piper*, and as it has distinct habital characteristics, differing widely from any true Pipers or Peperomias, I think it better regarded as a distinct genus under Miquel's name *Potomorphe*. Kunth, and also A. Dietrich, allowed it in *Peperomia*.

## 9. THE GENUS STEGNOSPERMA BENTH.

*Stegnosperma* was established by Bentham (Bot. Voy. Sulphur 17. *pl. 12.* 1844) with the single species *S. halimifolium* Benth. from Cape St. Lucas, Lower California. The next year, A. Richard (Ess. Fl. Cub. 632. 1845) proposed an additional species, *S. cubense* A. Rich. from Cuba. Moquin (in DC. Prodr. **13**$^2$: 36. 1849) makes no mention of the Cuban plant, though recording it from Guatemala, but in Bentham and Hooker (Genera Plantarum **3**: 86. 1880) the two supposed species are regarded as one, and its range extended to Santo Domingo.

The range is now extended to Jamaica, where the plant was found by us in the Healthshire Hills, an exceedingly dry region at about 100 meters elevation, south of Spanish Town (*Britton & Harris 10522; Britton 3062*); here it is a woody vine 8 m. long, climbing to the tops of low trees; its reddish fleshy fruits are 3-grooved, borne in short terminal racemes. The Mexican and Central American plant seems to me to be specifically identical with that of the West Indies, as maintained by Bentham and also by Heimerl in "Die natürlichen Pflanzenfamilien."

## 10. UNDESCRIBED SPECIES FROM JAMAICA

### **Dorstenia jamaicensis** Britton, sp. nov.

Rootstock erect, about 2 cm. long, 5 mm. thick, simple or branched, scarred by leaf-bases. Leaves 5–13; petioles flat, densely short-pubescent, 2–11 cm. long, about 1.5 mm. wide, erect or ascending, mostly longer than the blades; blades ovate to ovate-orbicular, rather firm in texture, 3–4.5 cm. long, 1.5–3.5 cm. wide, peltate below the middle, repand-dentate or nearly entire, papillose-scabrous above, short-pubescent beneath, especially on the 7–9 veins, which are slightly elevated and rather prominent; scape pubescent, about 2 cm. long, much shorter than the petioles; receptacle peltate, purplish, puberulent, 8–10 mm. broad, saucer-shaped, its margin with about 20 triangular-subulate teeth 0.5 mm. long; flowers dark purple.

On vertical limestone cliffs, Somerset, Parish of Manchester, Jamaica, Sept. 22, 1908 (*Britton 3737*, type; *Harris & Britton 10607*). An interesting addition to the West Indian peltate-leaved Dorstenias, three being known from Cuba and one from Santo Domingo.

### **Trichilia Harrisii** sp. nov.

A tree about 7 m. high, the twigs and leaves glabrous. Leaves 2–3 dm. long; petiole 1.5–2.5 cm. long; leaflets 5–9, flat, thin, oblong-lanceolate to ovate-elliptic, faintly pinnately veined with about 15 veins on each side of the midrib, narrowed or rounded and somewhat oblique at the base, rather long-acuminate at the apex, the larger ones 10–16 cm. long, 4–7.5 cm. wide; petioles 5–8 mm. long; fruiting panicles 15 cm. long or less, its branches finely appressed-pubescent; fruiting pedicels stout, 2–3 mm. long; capsule globose to oval, 1–2.5 cm. long, blunt or pointed, rugose, densely velutinous, tardily dehiscent.

In woods near summit of Dolphin Head Mountain, Hanover, Jamaica, March 18, 1908 (*Britton 2263*, type; *2269; Harris 10282*, *10286*).

## 11. ADDITIONS TO THE LIST OF JAMAICA SEDGES

In 1907 I contributed an enumeration of the sedges of Jamaica to the Bulletin of the Jamaica Department of Agriculture (**5**: Supplement 1). Further exploration of that island in the autumn of 1907 and in the spring and autumn of 1908 has disclosed the occurrence of some additional species and the habitat of others which were recorded by me from the statements of other botanists.

KYLLINGA INTERMEDIA R. Br. Prodr. 219. 1810.

Pasture, Cornwall near Lacovia (*Britton 1499*). Distribution: Cuba; Australia.

KYLLINGA PERUVIANA Lam. Encycl. **3**: 366. 1789.

Not uncommon in swamps along the coasts.

CYPERUS HUMILIS Kunth, Enum. **2**: 23. 1837.

East of Port Antonio (*Wight 54*); rocky thicket, Salem (*Britton 2542*); edge of water-hole, Lucea (*Britton 2906*). Distribution: Cuba; Martinique; Central America.

CYPERUS BROMOIDES Humb.; Link, Jahrb. **3**: 85. 1820.

Marsh west of Black River (*Britton 1353*). Distribution: Cuba; Haiti; California to Mexico and Paraguay.

CYPERUS OXYLEPIS Nees; Steud. Syn. Pl. Cyp. 25. 1855.

Ditches near Salt Ponds, south of Spanish Town (*Britton 3032*). Previously collected in Jamaica only by Alexander. Distribution: northern South America.

CYPERUS ESCULENTUS L. Sp. Pl. 45. 1753.

Ditch near Flat Bridge, Rio Cobre (*Britton 3092*). West Indian distribution: Bermuda; Cuba; Martinique; Guadeloupe.

CYPERUS DIGITATUS Roxb. Hort. Bengal. 81. 1813.

Border of Black River, Lacovia (*Britton 1482*). Distribution: tropical and subtropical regions of the Old World and the New.

CYPERUS ANCEPS Liebm. Mex. Halvgr. 25. 1850.

In my paper in the Jamaica Bulletin, I followed Mr. C. B. Clarke, in Urban, Symb. Ant. **2**: 44, in recording the continental North American *Cyperus tetragonus* Ell. from Jamaica, and in referring *C. anceps* to it as a synonym, but abundant material now convinces me that the species are distinct. This sedge is plentiful on grassy hillsides and banks in the parish of Manchester (*Britton 1024, 3161*); also at Woodstock near Newmarket, in Westmoreland (*Britton 1567*). Distribution: Cuba.

CYPERUS GRANULARIS (Desf.) Britton, Bull. Jam. Dept. Agric. **5**: Suppl. 1, 9. 1907.

Dry soil, Longacre Point (*Britton 1383*). Distribution: Haiti to St. Croix.

ELEOCHARIS CAPILLACEA Kunth, Enum. **2**: 137. 1837.

In mud, marsh west of Black River (*Britton 1354*). Distribution: southern United States; Cuba; South America.

FIMBRISTYLIS AUTUMNALIS (L.) R. & S. Syst. **2**: 97. 1817.

Border of pond, Cornwall, Lacovia (*Britton 1493*). Distribution: United States; Cuba.

RYNCHOSPORA JUBATA Liebm. Vidensk. Selsk. Skr. V. **2**: 254. 1851.

Marsh west of Black River (*Britton 1356*); border of Great Morass, Negril (*Britton 2116*). Distribution: Bahamas; Cuba; Mexico to Paraguay.

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CONTRIBUTIONS FROM THE NEW YORK BOTANICAL
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# NORTH DAKOTA SLIME-MOULDS

By FRED J. SEAVER

NEW YORK
1908

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# North Dakota slime-moulds

Fred J. Seaver

During the fall of 1907 and spring of 1908, in connection with the study of the fungus flora of North Dakota, a number of species of slime-moulds were collected, and since there is no available literature on this particular phase of the cryptogamic flora of the state, it is thought advisable to publish the list at this time. The work above mentioned was carried on in connection with the North Dakota Agricultural College and specimens of the species reported on here are preserved in the herbarium of that institution, to which I am indebted for the privilege of carrying on the work.

With few exceptions, such as that of the disease known as the club-rot of cabbage, the slime-moulds are not known to be of any economic importance, and since they are usually small and grow in out of the way places little attention is given to them. But notwithstanding their failure to appeal to those interested in the commercial phases of the botanical science only, their strange life-history, delicate structure, and uncertain relationship with other groups of plants and animals never fail to arouse the interest of the student in the class-room and it was for this reason that most of the species reported here were first collected.

In preparing this list acknowledgments are due to Professor T. H. Macbride, of Iowa, for identification or confirmation of the identification of the species named below.

## PHYSARACEAE

Cienkowskia reticulata (Albert. & Schwein.) Rost.

This is the only species of the genus and according to Professor Macbride, in the North American Slime-moulds, is very rare. The species was at first mistaken for an immature plasmodium, which it very closely resembles.

Diderma crustaceum Peck.

Common and rather attractive. The species has been collected several times in North Dakota, usually on the stems of herbaceous plants and often some distance above ground, an adaptation for spore distribution.

DIDYMIUM SQUAMULOSUM (Albert. & Schwein.) Fries.

On leaves and decaying materials of various kinds. A common species.

FULIGO OVATA (Schaeff.) Macbr.

This is a common species and one which often attains considerable size. One specimen collected on a rotten log in North Dakota was from six to eight inches in diameter and smaller specimens were found to be very common.

PHYSARUM CONTEXTUM Pers.

Several collections were made on decaying materials of various kinds in woods near Fargo.

TILMADOCHE VIRIDIS (Bull.) Sacc.

Plants collected on rotten wood. The species is not uncommon and has a wide distribution.

## STEMONITACEAE

STEMONITIS MAXIMA Schwein.

Numerous specimens were collected on bark and wood of *Tilia americana*, for which substratum it shows a decided preference. Widely distributed.

STEMONITIS SMITHII Macbr.

The specimens, collected in similar localities to the preceding, were mostly larger and easily distinguished from that species by the color of the spore mass, which is ferruginous instead of purplish black. Rather common.

## CRIBRARIACEAE

DICTYDIAETHALIUM PLUMBEUM (Schum.) Rost.

Several collections on decaying wood. The plants are depressed and spread out, becoming 1–2 cm. in diameter and recognized by these characters and the ochraceous color. The one species known to North America has a wide distribution.

DICTYDIUM CANCELLATUM (Batsch) Macbr.

One of the most variable species of the group, the plants being either long- or short-stemmed and very variable in color.

TUBIFERA FERRUGINOSA (Batsch) Macbr.

Collected on rotten wood and distinct in the tubiferous sporangia, which persist long after the shedding of the spores. The sporangia occur in dense masses.

## LYCOGALACEAE

LYCOGALA EPIDENDRUM (Bux.) Fries.

The young phases of this plant are often met with in woods, and the bright red color of the plasmodium of the forming sporangia make them rather conspicuous objects. At maturity, however, the sporangia lose their bright color and become more nearly the color of the substratum on which they occur. Said to be the most common slime-mould in the world.

## TRICHIACEAE

ARCYRIA INCARNATA Pers.

The plants of this species are often found closely crowded on rotten stumps, sometimes covering an area of several inches. At maturity the delicate threads of the capillitium push out so that the entire group of plants resembles rich flesh-colored velvet.

ARCYRIA DENUDATA (L.) Sheld.

Plants resembling those of the preceding species but distinguished by the dull reddish brown color. The species was found to be common but did not occur in such abundance as the preceding.

HEMITRICHIA CLAVATA (Pers.) Rost.

Common on rotten wood and distinguished by the stipitate, cup-shaped remains of the sporangia containing the golden yellow capillitium. The twisted rope-like appearance, which is one of the characteristics of the genus, is revealed only by microscopic examination.

HEMITRICHIA VESPARIA (Batsch) Macbr.

At once recognized in the field as distinct from the preceding by the dark reddish purple color of the sporangia. Several collections made on rotten wood. The species is common.

TRICHIA PERSIMILIS Karst.

Rather common and widely distributed in North America.

OLIGONEMA FLAVIDUM (Peck) Massee.

The sporangia of this species grow closely crowded together in little masses and the species is quite distinct in this character and the bright yellow color of the sporangia.

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CONTRIBUTIONS FROM THE NEW YORK BOTANICAL GARDEN—No. 120

# PHYCOLOGICAL STUDIES—IV.
# THE GENUS NEOMERIS AND NOTES ON OTHER SIPHONALES

By MARSHALL AVERY HOWE

NEW YORK
1909

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From the Bulletin of the Torrey Botanical Club, 36: 75-86 1909.

# Phycological studies — IV, The genus Neomeris and notes on other Siphonales

Marshall Avery Howe

(with plates 1–8)

## A. THE GENUS NEOMERIS

In an attempt to determine the relationships of a peculiar *Neomeris* collected on Atwood Cay in the eastern Bahamas and later on the Caicos Islands, it was found desirable to see the material on which *Neomeris dumetosa* Lamour., the original species of the genus, attributed to the Antilles, was founded. Having been allowed to see presumably authentic specimens of *N. dumetosa* through the courtesy of Monsieur P. Hariot of the Muséum d'Histoire Naturelle of Paris, we were further enabled, through the kindly interest of other European phycologists named below, to examine plants from the Friendly Islands, Singapore, the Dutch East Indies, etc., which had been identified with *Neomeris dumetosa.* A comparative study of these specimens and of our own collected in Bermuda, Florida, and the West Indies, indicates that the genus consists, so far as is known, of six living species. We have made no attempt to study the fossil forms that have been referred to the genus and we regret not being able to add anything as to the still unknown germination phenomena of the so-called "spore." The detailed life-history, not only of *Neomeris*, but of many other marine Siphonales of the tropics, remains to be worked out by some one so situated as to have the living plants under a more continuous and leisurely observation than has as yet fallen to the lot of the writer. A brief diagnosis of the genus and more detailed descriptions of the six species follow:

Neomeris Lamour. Hist. Polyp. 241. 1816.

Plants subcylindrical, clavate, or subfusiform, more or less calcified, consisting of an erect normally simple and unconstricted axis affixed at the base by branching or lobed holdfasts and bearing numerous close-set whorls of 12–56 or more branches.

Branches of the lowermost whorls commonly one or more times di-trichotomous and sterile; primary branches (branches of the first order) of the remaining whorls mostly giving rise to a terminal stalked sporangium and two (in *N. stipitata* sometimes three) sterile branches, the latter springing from near the base of the sporangium. Sterile branches of the second order in adult stage either enlarged and vesicular distally, the inflations strongly coherent and forming a unistratose cortex with more or less hexagonal facets, or in (*N. Cokeri*) merely subfusiform and imperfectly coherent, scarcely forming a cortex. Each of the sterile branches of the second order terminating in a single simple or one or more times di-trichotomous, soon deciduous hair. Sporangia subglobose, obovoid, pyriform, or somewhat cylindrical, enclosed in thick calcareous capsules, these sometimes coherent; the sporangium-stalk often at length cut off from the supporting primary branch by a basal constriction and plug. Each sporangium enclosing a single spore (gametangium?), this furnished with an operculum at its basal (proximal) end.

Type species *N. dumetosa* Lamour.

- Hairs monomorphous; ends of branches of the second order forming a cortex with distinct facets.
  - Sporangia strongly calcified but mutually free.
    - Primary branches 500–1000 μ long, 15–35 times as long as their median diameter.
      - Primary branches coherent by intercalary lime-deposits into flat, cuneate, flabelliform, or somewhat annular transverse scales or bands of mostly 3–8 branches, easily caducous; plants mostly 15–20 times as long as thick. 1. *N. dumetosa.*
      - Primary branches strongly calcified but free, or, at most, very irregularly and loosely coherent, persistent; plants mostly 6–12 times as long as thick. 2. *N. van Bosseae.*
    - Primary branches 240–410 μ long, 4–10 times as long as their median diameter.
      - Plants 26–40 mm. long; facets of the cortex firm-walled, not calcified on the outer surface, occasionally in threes; sporangia first appearing at about 15 mm. from base of mature plant. 3. *N. stipitata.*
      - Plants 8–20 mm. long; facets of the cortex thin-walled and very mucilaginous, strongly calcified at first on the outer surface, always in pairs; sporangia first appearing at about 2–6 mm. from base of mature plant. 4. *N. mucosa.*
  - Sporangia coherent laterally by their calcareous capsules, the plant thereby appearing transversely annulate in the lower fertile parts. 5. *N. annulata.*

Hairs dimorphous, the two forms in alternating zones; branches of the second order subfusiform, scarcely forming a cortex, surface of the plant after the fall of the hairs somewhat shaggy or minutely and irregularly punctate; sporangia free or coherent in short rows of 2–8. 6. *N. Cokeri.*

1. NEOMERIS DUMETOSA Lamour. Hist. Polyp. 243. *pl. 7. f. 8.* 1816; Expos. méth. Polyp. 19. *pl. 68. f. 10, 11* (*11* poor). 1821. — Cramer, Neue Denkschr. Schweiz. Naturf. Ges. **30**: —(10–14, 38). *pl. 2. f. 13–15; pl. 3. f. 3.* 1887. Not *N. dumetosa* Cramer, *op. cit.* **32**: —(19–21). *pl. 1. f. 13; pl. 2. f. 7, 8.* 1890.

Plants gregarious or scattered, subcylindrical, elongate and slender, 20–40 mm. long, 1–2 mm. thick, mostly 15–20 times as long as thick, acute or acuminate at apex: successive whorls of primary branches about 300–400 in number, 80–90 μ apart near the middle of the plant, 135 μ near apex; number of branches in a whorl usually 28–40: hairs all of one form, sparingly persistent in an inconspicuous apical tuft:* ends of branches of the second order in the mature stage forming a cortex with irregular hexagonal facets in irregular, often scarcely recognizable, transverse and oblique rows, each pair of corticating branches commonly lying in a somewhat oblique plane, cortex easily deciduous, usually persistent only in upper fourth or sixth, reticulate-alveolate on drying: branches of the first order in adult fertile stage 500–680 μ long, 14–30 μ in diameter in their median and basal parts, slender, mostly 18–35 times as long as their median diameter, soon very strongly calcified and regularly coherent by heavy intercalary deposits of lime into flat, cuneate, flabelliform, or somewhat annular densely crowded transverse scales or bands, these consisting usually of 3–8 branches with the intercalary masses of lime 2–4 times as broad as the branches, very easily caducous, the main axis often becoming extensively naked in basal and median parts: branches of the second order capitate, the terminal inflations 100–185 μ in greatest diameter, outwardly rounded-obtuse, their walls moderately gelatinous, the pedicels scarcely calcified, the terminal inflations strongly calcified proximally and laterally but not on their outer surfaces: sporangia strongly calcified but mutually free, first appearing at 2–3 mm. from base of the mature plant, soon deciduous, persisting in irregularly crowded groups or loosely scattered, 150–200 μ long (decalcified and including stalk), the calcareous capsule 16–50 μ thick; spores subglobose, 135–

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* The apparently conspicuous apical tuft shown in Lamouroux's figure 3 consists quite largely, judging from specimens in the Paris Museum, of young uncalcified collapsed facets from which the hairs have already fallen.

160 μ × 130–154 μ, commonly a trifle longer than broad or occasionally *vice versa* (sometimes only 100–110 μ in diameter in the East Indian specimens). [PLATE 1, FIGURE 1; PLATE 5, FIGURE 20; PLATE 6, FIGURES 1, 2.]

TYPE LOCALITY: "Antilles." Probable type specimens in herb. Lamouroux, Institut Botanique, Caen, France, under the manuscript name "*Neomeris cespitosa*"; probable co-types in herb. Mus. Paris., under names "*Neomeris cespitosa*" and "*N. dumetosa* Lmx."

DISTRIBUTION: "Antilles," *Richard;* island of Fau (near the island of Gebee), Dutch East Indies, *A. Weber-van Bosse* (apparently associated with *N. van Bosseae*).

The only specimens found in the *Neomeris* cover in herb. Lamouroux are three plants attached to a slip of paper bearing the inscription "*Neomeris cespitosa*" in Lamouroux's hand, without indication of locality or collector. They are doubtless the three plants figured by Lamouroux in connection with the original publication of *Neomeris dumetosa*, though now occupying slightly different positions in relation to each other. In the herbarium of the Muséum d'Histoire Naturelle of Paris, in which the Richard herbarium is incorporated, is a single plant in a pocket marked "*Neomeris cespitosa*" without collector or locality, and also a group of seven individuals (six practically entire and one a basal fragment) marked "*N. dumetosa* Lmx.," also without indication of locality or collector. All of the specimens mentioned resemble each other closely and all have probably come from the one original collection. We examined all of these specimens in the summer of 1904, but then neglected to note certain characters which we have since found to be of importance in distinguishing the species of *Neomeris.* Recently, however, through the generous courtesy of M. Hariot, we have enjoyed the privilege of making a more critical study of the material in the Paris Museum. Cramer saw an authentic specimen of *Neomeris dumetosa* and gave an excellent description of it (with characteristic figures) in his first paper "Ueber die verticillirten Siphoneen besonders Neomeris und Cymopolia," but in his second paper "Ueber die verticillirten Siphoneen besonders Neomeris und Bornetella" he described under the same name some of Harvey's specimens from the Friendly Islands, which, we believe, are specifically distinct.

Later descriptions by other writers, also, have been based, in part, at least, on specimens agreeing with the true *N. dumetosa* in having mutually free sporangia but differing in various other particulars.

Just as the lateral coherence of the sporangia by their calcareous capsules forms a reliable and easily applied test for distinguishing *Neomeris annulata* from *N. dumetosa* and its near allies, so the similar coherence of the primary branches of the true *Neomeris dumetosa* by intercalated lime-deposits constitutes an apparently constant and reliable character for distinguishing the species from others which have hitherto been identified with it. This coherence was recognized by Lamouroux in his original description by the words "inferne squamosa" and "écailles presque cunéiformes" and was emphasized by Cramer in his first description, but has been generally ignored by subsequent writers. This character is well illustrated by Cramer (*pl. 2. f. 13*), his figure showing the calcareous scale perforated by the tubular branches, with the width of the connecting lime-masses commonly three or four times the diameter of the branches. Another peculiarity of the true *Neomeris dumetosa* is found in the very caducous nature of these scales. As Lamouroux well said, "le moindre frottement les arrache du tube membraneux qu'elles laissent alors à nu." In allied species which have been confused with *N. dumetosa*, the individually separate primary branches are persistent. Furthermore, the mature plants of *N. dumetosa* are more slender and more taper-pointed than those from the Friendly Islands, the Dutch East Indies, and Hawaii, which have hitherto been identified with it.

*Neomeris dumetosa* is said to have been brought from the Antilles by Richard and there is as yet no sufficient ground for doubting the accuracy of this statement in spite of the facts that it apparently has not since been collected in American waters and that something practically identical (except for smaller spores) has recently been brought from the East Indies by Madame Weber-van Bosse. *Neomeris Cokeri* is common enough in the Bahamas (we have it from fourteen stations and have seen it often when not collected), but the species has not yet been reported outside of this group of islands. *Neomeris mucosa*, described as new in the present paper, is known only from the Caicos Islands and the extreme eastern Bahamas. And *Neomeris dumetosa* will possibly be found again in the West Indies when some collector of marine algae visits the right island. And, furthermore, the occurrence of this species in both the West Indies and the East Indies may occasion no surprise in view of the fact that *Neomeris annulata* and various other marine Siphonales are now generally conceded to have a similar distribution. In connection with the original description of *Neomeris dumetosa*, it is said to grow associated with *Acetabularia crenulata*, a species which appears to be exclusively American. The Paris Museum material of the probably original *N. dumetosa* is intermingled with a few broken stalks of plants apparently belonging in the genus referred to, but without caps or sporangia a determination of the species is out of the question.

### 2. **Neomeris van Bosseae** sp. nov.

*Neomeris dumetosa* Sonder, Alg. trop. Austral. 36. *pl. 5. f. 8–13.* 1871. — J. Ag. Till. Alg. Syst. **5**: 147–151. *pl. 2. f. 4–7.* 1887. — Cramer, Neue Denkschr. Schweiz. Naturf. Ges. **32**: —(19–21). *pl. 1. f. 13; pl. 2. f. 7. 8.* 1890. — Solms, Ann. Jard. Bot. Buitenzorg **11**: *pl. 8. f. 11.* 1893. Not *Neomeris dumetosa* Lamour. Hist. Polyp. 243. *pl. 7. f. 8.* 1816.

Plants gregarious or scattered, clavate, subcylindrical, or somewhat fusiform, 15–35 mm. long, 2–3.5 mm. thick, mostly 6–12 times as long as thick, often curved near the middle or toward the rounded-obtuse or subacute apex: successive whorls of primary branches about 290–350 in number, 50–80 μ apart in basal and median regions, 150–170 μ toward apex; number of branches in a whorl usually 32–44: hairs all of one form, persistent in a moderately conspicuous apical tuft: ends of the branches of the second order in the mature stage forming a cortex with the hexagonal facets in regular or irregular rows, each pair of corticating branches commonly lying in a transverse plane, the number of transverse rows of facets equaling, in consequence, the number of primary whorls, and the number of facets in a row being twice that of the elements in a primary whorl, or, the pairs of corticating branches lying in oblique planes and the arrangement of the facets then less manifestly regular, cortex rather brittle, yet usually persisting in upper third or half, reticulate on drying: branches of the first order 570–1000 μ long, 20–50 μ in diameter in their basal and median parts, mostly 15–30 times as long as their median diameter, soon strongly calcified but remaining distinct and free from each other, or very irregularly and loosely coherent, persistent: branches of the second order capitate, the terminal inflations 110–220 $\mu$ in greatest diameter, outwardly subtruncate or lightly arcuate, their walls rather firm, the pedicels well calcified as to their bases at least or sometimes nearly free from lime, the terminal inflations strongly calcified proximally and laterally, but their outer surfaces, with rare exceptions, uncalcified and nitent: sporangia strongly calcified but mutually free, first appearing at 1–4 mm. from base of mature plant, commonly long persistent, 135–220 $\mu$ long (decalcified and including stalk), the calcareous capsules 20–55 $\mu$ thick; spores subglobose or oval, 105–176 $\mu \times$ 96–170 $\mu$, their width often about $\frac{11}{12}$, rarely $\frac{4}{5}$, their length. [PLATE 1, FIGURES 4, 7; PLATE 5, FIGURES 17–19.]

Type from Sikka, Flores, Dutch East Indies, *A. Weber-van Bosse 1196*, in the herbarium of the New York Botanical Garden and in the herbarium of Madame Weber-van Bosse, Eerbeek, Holland. Known also from Savoe [Savu], Dutch East Indies, *Weber-van Bosse*; from Vavau and Lifuka, Friendly Islands, *W. H. Harvey*, August and October, 1855; and from Koolauloa. Oahu, Hawaii, *Josephine E. Tilden*, June, 1900, Am. Algae *445*. The specimens from New Guinea, *Beccari*, cited by Solms (*loc. cit.* 71), under *N. dumetosa* we have not seen, but it is quite possible that they belong here, as this seems to be the most common species of the group in that region.

It is a pleasure to associate with the present species the name of one of its collectors, Madame A. Weber-van Bosse, who had already recognized that her material of the *Neomeris dumetosa* group included two species, and to whom the writer, like many other students of the marine algae of the present day, is indebted for numerous most helpful courtesies. J. Agardh (*loc. cit.*) seems never to have seen Richard's West Indian plant and in describing *Neomeris dumetosa* from Harvey's material from the Friendly Islands he gave evidence of some doubts as to whether the two were really the same.

*Neomeris van Bosseae* agrees with *N. dumetosa* in its mutually free sporangia, but the two, so far as can be judged from the material now in hand, appear to be sufficiently and constantly distinct. The most obvious distinguishing character of *N. van Bosseae* is that the branches of the first order, though strongly calcified, remain mutually free. If there is any irregular or accidental coherence among them, there is no approach to the beautifully regular coherence of *N. dumetosa*, and the lime-masses between the branches are narrower than the branches, while in *N. dumetosa* they are, except at their bases (or sometimes, also, at their apices), 2–4 times as broad as the branches themselves. Moreover, the primary branches of *Neomeris dumetosa* are easily deciduous or caducous, while in *N. van Bosseae* they are persistent, and the sporangia also, show a similar tendency quite apart from branches on which they are borne. *Neomeris van Bosseae* is also a stouter plant than *N. dumetosa*, being mostly 6–12 times as long as thick, as opposed to 15–20 times as long as thick, and it is usually more rounded-obtuse at the apex.

The arrangement of the facets in the cortex appears to be somewhat variable in *N. van Bosseae*. When, as is often the case, the members of each pair of corticating branches are opposed to each other laterally, that is, lie in a transverse plane, the arrangement is manifestly regular, the number of transverse rows of facets corresponds exactly to the number of primary whorls, and the number of facets in each row is consequently just twice the number of elements in the corresponding primary whorl. But when, on the other hand, the members of each pair lie in an oblique plane, there are two possible ways of interpreting what shall constitute a transverse row of facets and, according to the method adopted, there may be either twice as many rows as there are primary whorls or only the same number. A change from the regularly transverse arrangement to the oblique may sometimes be noted in the different parts of a single individual plant.

### 3. **Neomeris stipitata** sp. nov.

*Neomeris dumetosa* Church, Ann. Bot. **9**: 581–608. *pl. 21–23.* 1895. Not *Neomeris dumetosa* Lamour. Hist. Polyp. 243. *pl. 7. f. 8.* 1816.

Plants cespitose or gregarious, elongate-clavate, lightly calcified, 26–40 mm. long, 2–2.5 mm. thick, mostly 13–20 times as long as thick, subacute at apex: successive whorls of primary branches about 300–500 in number, 90–120 $\mu$ apart in median regions; number of branches in a whorl in later stages usually 16–32: hairs all of one form, persistent in the apical fourth to sixth and making a rather conspicuous coma: ends of branches of the second order in the mature stage forming a cortex with irregularly hexagonal facets in mostly very irregular transverse rows or often without recognizable order, each pair of corticating branches lying in a transverse or somewhat oblique plane, the corticating branches occasionally in threes, cortex rather pliable, commonly persistent in the upper half, plants of a younger stage often somewhat extensively corticated by inflations of the primary branches: branches of the first order in adult fertile parts 240–410 μ long, 32–42 μ in diameter in their basal and median parts, mostly 6–10 times as long as their median diameter, lightly calcified, free, persistent, the main axis commonly clothed for a space of 10–15 mm. in the lower sterile half by clavate 2-scarred long-persistent scarcely calcified primary branches 150–240 μ long: branches of the second order mostly in pairs but now and then in threes, capitate, the terminal inflations 116–215 μ in greatest diameter, outwardly mammiform, subconical, domed, or merely arcuate, their walls firm, the pedicels uncalcified, the terminal inflations lightly or moderately calcified proximally, their outer surfaces uncalcified: sporangia rather strongly calcified, mutually free, first appearing at about 15 mm. from base of the mature plant, 185–210 μ long (decalcified and including stalk), the calcareous capsules 11–28 μ thick; spores subglobose or slightly obovoid, 142–172 μ × 132–144 μ. [PLATE 1, FIGURE 3; PLATE 5, FIGURES 15, 16.]

*Neomeris stipitata* was collected at Singapore by Mr. H. N. Ridley or one of his assistants and was described and figured with much thoroughness and detail by Dr. Arthur H. Church of Jesus College, Oxford, in the Annals of Botany in 1895, as quoted above. Type material of the species is preserved in the herbarium of the New York Botanical Garden and in the botanical department of the museum of Oxford University.

*Neomeris stipitata* differs rather strikingly in several particulars from the other members of the *N. dumetosa* group. The specimens, which have been preserved in alcoholic media (ours transferred lately to 50 per cent. glycerine), are, at the present time, at least, very much less calcified than those of any other known species of the genus. Dr. Church writes us that he believes they have lost fully 50 per cent. of their lime since he studied them in 1895, but even at that time (*loc. cit.* 582) he was impressed by their "delicately calcified" condition as compared with the "densely calcified" *N. Kelleri* Cramer. Another peculiarity of *N. stipitata* is found in its long sterile basal portion, constituting nearly half the length of the adult plant, while in the allied species the sporangia appear within 1–4 mm. of the base of the adult plant. The branches of the first order are short, 150–410 μ long as compared with 500–1000 μ long in *N. dumetosa* and *N. van Bosseae*, and are 6–10, instead of 15–35, times as long as their median diameter. The corticating branches of the second order are quite often in threes instead of being uniformly in pairs, a character which, apparently, was not observed by Church and which has thus far not been noted in any other species of the genus. Partly as a result of the interpolation of these trimerous elements in the cortex, the arrangement of the facets is commonly very irregular, rather more so than might be inferred from Church's figures, 17, 21, and 24. The hairs, also, are less gelatinous, more rigid, more persistent, and more conspicuous than in other species of the genus.

### 4. **Neomeris mucosa** sp. nov.

Plants cespitose, mostly in clusters of 3–20, subcylindrical or subfusiform, 8–20 mm. long, 1.5–2.5 mm. thick, mostly 4–8 times as long as thick, bright or yellowish green in upper tenth to third, becoming chalky- or dingy-white below, apex often appearing somewhat obtuse or truncate when living, but commonly acute or acuminate on drying: successive whorls of primary branches mostly 120–300 in number, 85–150 μ apart in median regions; number of branches in a whorl in later stages usually 28–48: hairs all of one form, soft and mucilaginous, di-trichotomous above, a rather conspicuous chlorophylose tuft persisting at the apex: ends of branches of the second order in the mature stage forming a cortex with irregularly hexagonal or somewhat rhombic or triangular facets in close rather regular or at length sometimes not easily recognizable transverse rows, each pair of corticating branches lying in an obliquely radio-vertical plane, there being consequently twice as many transverse rows in the cortex as there are primary whorls, the number of facets in each row equaling the number of members in the primary whorl, the cortex usually persisting in the upper half and deeply alveolate on drying: branches of the first order of the first 10–12 whorls of the juvenile stage cylindrical, each commonly bearing three di-trichotomous assimilatory filaments; the succeeding branches of the first order in the younger stages cylindrical, clavate, or somewhat fusiform, 275–400 μ long, 95–115 μ in diameter, each bearing a pair of deciduous di-trichotomous assimilatory filaments, the primary branches mostly persisting, soon strongly calcified and more or less coherent in well separated, often somewhat divergent or reflexed transverse rings or bands of 2–6 or more, the sheathing lime-tubes showing on drying conspicuous orifices about 80 μ in diameter, thickness of the lime-sheaths usually less than half the diameter of the branch ; mature corticated plants sometimes reverting toward the apex and bearing there whorls of filamentous non-corticating branches ; branches of the first order of the mature stage cylindrical or clavate, 275–400 μ long, 40–72 μ in diameter in their basal and median parts, mostly 4–9 times as long as their median diameter, moderately and rather diffusely calcified, scarcely coherent, persistent : branches of the second order capitate, the terminal inflations 100–220 μ in greatest diameter, outwardly mammiform, subconical. or subrostrate, their walls thin, very mucilaginous, and often not easily visible after decalcification, the pedicels scarcely calcified, the terminal inflations strongly calcified throughout their entire surface, proximally, laterally, and distally, the lime-coating of the outer surface soon flaking off, usually persisting a little longer than the hairs : sporangia strongly calcified but mutually free, commonly appearing within 2–6 mm. from base of adult plant, 178–215 μ long (decalcified and including stalk), the calcareous capsule 20–55 μ thick ; spores obovoid, 140–160 μ × 104–121 μ, their width usually $\frac{4}{5}$ to $\frac{2}{3}$ their length. [Plate 1, figure 5 ; plate 5, figures 1–14.]

Growing on moderately exposed rocks, at and near low-water mark, usually associated with *Neomeris Cokeri* and sometimes also with *N. annulata :* Atwood (Samana) Cay, Bahamas, *Howe, 5308* (type) ; Cockburn Harbor, South Caicos, *Howe 5548 ;* Great Ragged Island, Bahamas, *Howe 5771.*

*Neomeris mucosa* is a well-marked species, differing from the other known species of the genus in the extremely gelatinous diaphanous character of its membranes, particularly those of the corticating utricles. After decalcification it is often difficult to trace the outlines of the various members of the plant-body, with the exception of the sporangia. From *N. dumetosa*, it differs, furthermore, in being a shorter and relatively stouter plant (8–20 mm. *vs.* 20–32 mm. long ; 4–8 times *vs.* 15–20 times as long as thick), in the shorter and stouter primary branches (275–400 μ *vs.* 500–680 μ long ; 4–7 times *vs.* 18–35 times as long as their median diameter), which are persistent and scarcely cohere in scales if we except those that belong to the earlier phases of development (and even then the coherence is of a different sort), in the calcification of the outer surfaces of the corticating facets, and in the distinctly obovoid spores. From *N. van Bosseae*, it differs also in its usually smaller size, in the shorter and stouter primary branches (275–400 μ *vs.* 570–1000 μ; 4–7 times *vs.* 15–30 times as long as their median diameter), which commonly cohere in a peculiar fashion in the earlier stages of the plant's ontogeny, in the not unusual reversions to the branches of the primary form, in strong calcification of the outer surfaces of the corticating facets, in the more obovoid spores, etc.

The earlier stages in the development of *Neomeris mucosa* are quite different from those of *N. annulata* and *N. stipitata*, in which species alone the earlier stages have previously been described and figured. Church * has distinguished five stages in the development of the Singapore plant, which we have in the present paper named *N. stipitata*. In *N. mucosa* we have noted but two or, at most, three, recognizable stages. While the plant is bearing its first 10 or 12 whorls the primary branches are cylindrical and each bears, as a rule, three assimilatory filaments (FIGURES 1 and 2). This possibly might be called stage I, but it is poorly defined and passes very gradually into a condition that is continued for many successive whorls — one in which the primary branches become stouter, often at length somewhat elongate barrel-shaped, each bearing two deciduous assimilatory filaments (FIGURES 3–5). The transition from this condition to the corticated sporangium-bearing state is abrupt. It is possible that corticating branches of the second order sometimes spring from sterile primary branches (Church's stage IV) but we have been unable to demonstrate that such is the case in the present species. Church's stage II, in which what appears to correspond to the original branch is divided into two segments, and his stage III, in which the basal segments are irregularly dilated so as to form a sort of cortex, appear to be wholly absent in *Neomeris mucosa*. In *Neomeris annulata*, according to Cramer, † the primary branches of the earlier whorls each bear, with few exceptions, only a single deciduous assimilatory hair, and the primary branches, as shown also by Solms, ‡ are, in several or many of the later whorls, irregularly dilated so as to form a kind of cortex much as in *N. stipitata.* In *N. mucosa* we have never seen a primary branch terminating in a solitary hair and we have never seen the primary branches inflated in such a way as to simulate a corticating layer. The material of *N. annulata* figured by Cramer in connection with the characters mentioned came from Bermuda, and that figured by Solms was from Mauritius. In specimens of *N. annulata* from Bermuda we are able to confirm the observations of Cramer and of Solms, so far as concerns the stages studied and figured by them, but in a juvenile condition, showing only the first two whorls of branches, we find the branches of the second order in pairs.

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* Ann. Bot. 9 : 581–608. *pl. 21–23.* 1895.

† Neue Denkschr. Schweiz. Naturf. Ges. 32 : — (14, 15). *pl. 1. f. 1, 2, 3, 5.* 1890.

‡ Ann. Jard. Bot. Buitenzorg 11 : *pl. 8. f. 1, 13.* 1893.

*Neomeris mucosa* is preserved less well by adding formaldehyde to seawater than is the case with *N. annulata* and *N. Cokeri.* After a few weeks in such a solution, the plants can scarcely be handled without breaking across the main axis.

5. NEOMERIS ANNULATA Dickie, Jour. Linn. Soc. Bot. **14**: 198. 1874. — Solms, Ann. Jard. Bot. Buitenzorg **11**: 62–71. *pl. 8. f. 1, 3, 4, 7, 8, 12, 13, 17.* 1893. — Börgesen, Bot. Tidsskr. **28**: *272. f. 1, 2.* 1908.

*? Corallina vermicula* Nelson & Duncan, Trans. Linn. Soc. Bot. II. **1**: 200, 201. *pl. 26. f. 14–17.* 1876.

*Neomeris Kelleri* Cramer, Neue Denkschr. Schweiz. Naturf. Ges. **30**: — (3–10, 39). *pl. 1; pl. 2. f. 1–12; pl. 3. f. 1, 2.* 1887; **32**: — (9–19). *pl. 1. f. 1–12; pl. 2. f. 1–6; pl. 4. f. 15–24.* 1890. — Vickers, Phyc. Barbad. **1**: *pl. 46.* 1908.

Plants scattered or more often densely gregarious, subcylindrical or somewhat fusiform-clavate, 5–25 mm. long, 1–2 mm. thick, light or yellowish green in upper half or third, becoming chalky-white below, subacute, in dried condition often appearing rather gradually tapering: successive whorls of primary branches mostly 60–175 in number, 115–250 $\mu$ apart in median regions; number of branches in a whorl 20–56: hairs all of one form, soon deciduous, persisting in a small apical tuft: ends of branches of the second order forming a cortex with hexagonal facets in transverse rows, each pair of corticating branches lying in a radio-vertical or somewhat oblique plane, there being consequently twice as many transverse rows in the cortex as there are primary whorls, the number of facets in each row equaling the number of members in the primary whorl, the cortex persisting in the upper half or three fourths and regularly reticulate or reticulate-alveolate on drying; plants of the younger stages often more or less corticated by irregular inflations of the primary branches: branches of the first order in the adult stage 200–280 μ long, 11–20 μ in diameter in their basal and median parts, mostly 12–21 times as long as their median diameter, at length strongly calcified and often more or less coherent laterally, the width of the intervening lime-masses commonly less than the diameter of the branches, which are persistent or sometimes deciduous in basal parts: branches of the second order strongly calcified and coherent by a continuous lime layer, capitate, the terminal inflations 80–135 μ in greatest diameter, outwardly gently arcuate or rounded-obtuse, occasionally acute or subrostrate, rather firm-walled, their outer surfaces uncalcified: sporangia strongly calcified and coherent laterally by their capsules, forming nearly complete or more or less interrupted transverse rings, mostly 165–230 μ long (decalcified and including stalk), the calcareous capsules 15–60 μ thick; spores oblong-obovoid to oblong-ellipsoidal, 115–175 μ × 46–80 μ, usually about twice as long as broad. [PLATE 1, FIGURE 2.]

TYPE LOCALITY: Mauritius; type specimen in the herbarium of the British Museum (Natural History).

DISTRIBUTION: Bermuda, southern Florida, and the West Indies; Mauritius, Madagascar, Savoe (Dutch East Indies, *Weber-van Bosse*); reported by Solms also from Cobija, Bolivia (now Chile) and from Tongatabu, Friendly Islands. The Mauritius type of *N. annulata* we have seen in the herbarium of the British Museum, but we have not made a microscopic examination of it. Judging, however, from the excellent figures given by Cramer and by Solms, and from East Indian specimens kindly communicated by Madame Weber-van Bosse, there is nothing to indicate that the plant of the Atlantic Ocean can be distinguished even varietally from that of the Indian and Pacific oceans. We have thus far collected *Neomeris annulata* at twenty-one stations in Bermuda, southern Florida, the Bahamas, Porto Rico, and Jamaica; Börgesen has reported the species from four stations in the Danish West Indies; and Miss Vickers has figured it from Barbados specimens. It grows on rocks, stones, and shells, in sheltered or moderately exposed places, usually near the low-water mark, though Dr. Börgesen records a specimen from a depth of 50 m. in the Danish West Indies.

6. NEOMERIS COKERI M. A. Howe, Bull. Torrey Club **31**: 97. *pl. 6. f. 3–12.* 1904; **32**: 580. 1905.

Plants solitary or cespitose, rarely widely gregarious, subcylindrical or clavate, 7–37 mm. long, 1.5–3 mm. thick, dark green in upper third or fifth, becoming grayish white below, apex rounded-obtuse or subtruncate, often exhibiting a delicate, translucent apiculum formed of the mantle-caps: number of successive whorls of branches mostly 60–175; number of branches in a whorl 12–56: hairs of two forms in separate alternating zones, those of one form consisting of a single, clavate, often curved or somewhat hooked cell rich in chlorophyl and having a maximum diameter about equal to that of the supporting cell, the apex acute, obtuse, or more often apiculate; those of the second form consisting of a somewhat similar though slightly narrower basal cell bearing at its apex one or two earlier caducous, more slender branches, these in turn each bearing 2–4 branches; unicellular hairs and basal cells of the multicellular persisting in the upper third or fifth of the plant, the surface after their fall appearing somewhat shaggy or minutely and irregularly punctate, a cortex being scarcely developed: branches of the first order lightly calcified, scarcely coherent; branches of the second order more strongly calcified, irregularly and imperfectly coherent, subfusiform, often somewhat curved or gibbous, broadest (100–150 μ) a little above the middle, tapering to a conico-truncate apex 22–34 μ broad at the insertion of the hair: sporangia strongly calcified, free or coherent in short rows of 2–8, 180–260 μ long (decalcified and including stalk), calcareous capsule 25–40 μ thick; spores obovoid or oblong-ellipsoidal, 140–190 μ × 82–94 μ. [PLATE 1, FIGURE 6]

TYPE LOCALITY: Opposite Current Town, Eleuthera, Bahamas.

DISTRIBUTION: Bahamas; commonly under shelving rocks, near low-water line.

We now have this very peculiar species from fourteen stations, all within the Bahamian archipelago.

## B. TWO WEST INDIAN SPECIES OF ACETABULUM* OF THE POLYPHYSA SECTION

### **Acetabulum pusillum** sp. nov.

Plants minute, short-stalked, 1–3 mm. high, grayish green, well calcified throughout but with especially heavy deposits of lime between the rays, the lime-coating often flaking off at maturity: disc solitary, nearly flat, 1–2.5 mm. in diameter; sporangia (rays) 6–17 (mostly 11–15), obovoid-clavate to clavate-subfusiform, 2–3½ times as long as greatest width (which is at two thirds or three fourths of their length), bluntly subconical, obtusely taper-pointed, or occasionally rounded obtuse, rather easily separable and often more or less free on drying, mostly free in mature specimens after decalcification; coronal processes very small, short-cylindrical, slightly enlarged at the top and appearing oval or orbicular in surface view, 22–35 μ in greatest diameter, each bearing 2 (rarely 3) hairs, hair-rudiments, or hair-scars; hypopeltal processes wanting: aplanospores 15–60 in a sporangium, globose or ellipsoid, 68–82 μ in greatest diameter: stipe occasionally corrugated and enlarged in the upper part, 0.1–0.2 mm. in maximum diameter. [PLATE 6, FIGURES 13–15; PLATE 7, FIGURES 1–4.]

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* In the Botanisk Tidsskrift **28**: 274, 275. 1908, Dr. F. Börgesen has remarked upon the present writer's employment of the generic name *Acetabulum* instead of the more usual *Acetabularia*, giving there the impression that the use of 1753 as the initial date

On a reef, near low-water mark, with *Neomeris annulata* and *Acetabulum polyphysoides*, Montego Bay, Jamaica, *Howe 5029a* (type), January 19, 1907; Mariguana, Bahamas, *Howe 5453;* Castle Island, Bahamas, *Howe 5731b.*

*Acetabulum pusillum* differs from *A. polyphysoides*, with which it is sometimes associated, in its smaller size, in being strongly calcified throughout, in the character of the coronal processes, which are only 22–35 μ instead of 75–150 μ in diameter and bear only 2 (rarely 3) instead of 5–13 hairs, and in the smaller aplanospores, which are 68–82 μ instead of 88–190 μ in diameter. It is one of the most minute of the species thus far described in the genus, the average diameter of the disc being about 1.6 mm.

The nearest relatives of *Acetabulum pusillum* are apparently two East Indian species; *Acetabularia exigua* Solms * and *A.*

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of botanical nomenclature would prevent the adoption of *Acetabulum*. As a matter of fact, the generic name in its original Tournefortian form was used in Boehmer's edition of Ludwig's Definitiones Generum Plantarum (p. 504) in 1760, Tournefort being there cited, as he was cited also by Linnaeus two years earlier, in establishing the binomial *Madrepora Acetabulum* (Syst. Nat. 793. 1758), so the name is technically free from whatever opprobrium there may be in prelinnaeanism. The generic name *Acetabulum* was used also by Lamarck in 1816 (Hist. Nat. Anim. sans Vertèb **2**: 149), though this fact has no bearing on the priority question, as it was four years later than Lamouroux's establishment of *Acetabularia* (Nouv. Bull. Sci. Soc. Philom. **3**: 185. 1812). However, *Olivia* (Bertol. Rar. Pl. Ital. Dec. **3**: 117. 1810), to which no valid exception can be taken, antedates *Acetabularia* and must be preferred to it under any enforcement of priority principles, unless a comparatively modern date be taken as a starting point. Under the circumstances, we prefer the original *Acetabulum*, which has a clear post-1753 claim upon our favor.

* Trans. Linn. Soc. Bot. II. **5**: 28. *pl. 2. f. 1, 4.* 1895.

*parvula*[*] Solms, described from material collected by Mme. Weber-van Bosse at Macassar, Celebes, and vicinity; yet the West Indian plants in our opinion cannot be well identified with either one of these East Indian forms, specimens of which we have seen through the generosity of the collector. Of the character of the calcification in *Acetabularia exigua*, Solms states "I am unable to say anything more definite as to the calcification of the sporangial membrane of this species than that the few sterile specimens from Macassar were uncalcified. The others came under my observation only after lengthened treatment with acid. However, their sporangial rays are so widely separated from each other that a union of these by means of lime-incrustation is scarcely likely." In the single specimen of *A. exigua* that we have seen the rays are entirely free, spore-bearing, and are well incrusted with lime over their whole surface except for their apices and small areas here and there which have been left naked and smooth by an evident flaking-off of the lime-crust. The aplanospores in this specimen are 82–91 μ in diameter. From *Acetabularia exigua* Solms, *Acetabulum pusillum* differs in its usually smaller size, in the more coherent, less pointed, commonly more numerous rays, which are broadest at two thirds or three fourths their length instead of near their middle, and in the smaller coronal processes, which nearly always bear two instead of three hairs or hair-rudiments.

In *Acetabularia parvula* Solms, the calcification of the disc is confined to the contact faces of the rays and to a narrow sharply defined zone involving the bases of the rays and flanking the coronal processes; the projecting interradial lime-buttons, described and figured by Solms, are apparently not always present, and such, so far as we have observed, are wholly wanting in *Acetabulum pusillum*. *Acetabulum pusillum* further differs from *Acetabularia parvula* Solms in its commonly smaller size, in the often fewer, usually pointed, instead of rounded-obtuse or subtruncate-obtuse, rays, which are broadest at two thirds or three fourths their length instead of at their extreme ends, and in the smaller coronal processes (22–35 μ *vs.* 42–55 μ), which in nearly all cases bear two instead of three or four (!) hairs; the aplanospores of the East Indian plant are still undescribed.

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[*] *Loc. cit.* 29. *pl.* 2. *f.* 3, 5.

ACETABULUM POLYPHYSOIDES (Crouan) Kuntze, Rev. Gen. Pl. **2**: 881. 1891

*Acetabularia polyphysoides* Crouan; Schramm & Mazé, Essai Alg. Guad. 101. 1866; Mazé & Schramm, Essai Alg. Guad. 84. 1870–77 (*nomen seminudum*); — Solms, Trans. Linn. Soc. Bot. II. **5**: 29. *pl. 4. f. 2, 6.* 1895; Vickers, Phyc. Barbad. **1**: *pl. 47.* 1908.

Plants small, short-stalked, 2–7 mm. high, light green, rays of the disc little calcified except in the contact-areas, the interradial lime-masses shorter than the rays and inconspicuous (sometimes almost wanting) or slightly projecting at the margin with flabelliform or inversely deltoid apical expansions: disc nearly flat or cup-shaped, solitary, 2–5 mm. in diameter, the margin subentire or stellate-dentate; sporangia (rays) 11–25 (mostly 11–18), varying from inflated-obvoid and about twice as long as broad to clavate-cylindrical or subfusiform and 3–5 times as long as greatest width, rather easily separable and often more or less free, rounded-obtuse at apex or obtusely taper-pointed, obtusely subrostrate or bluntly subconical; coronal processes knob-like, oval-elliptical in surface view, 75–150 μ in longest (radial) diameter, each bearing 5–13 (usually 8–10) hairs, hair-rudiments, or hair-scars arranged in an elliptical manner; hypopeltal processes wanting: aplanospores 6–50 in a sporangium, globose, ovoid, or ellipsoid, 88–190 μ in greatest diameter: stipe usually much corrugated, often enlarged in the upper part, reaching a maximum diameter of 0.35–0.70 mm. [PLATE 6, FIGURES 16–20; PLATE 7, FIGURES 5–9.]

Low littoral to at least 4–5 m. of water. Pointe-à-Pitre, Guadeloupe, *Mazé*; Atwood Cay, Bahamas, *Howe 5310, 5212*; Malcolm Road, Caicos Islands, *Howe 5652*; Castle Island, Bahamas, *Howe 5731a*; Montego Bay, Jamaica, *Howe 5029b*.

**Acetabulum polyphysoides deltoideum** forma nova. Sporangia (rays) mostly 7, vesicular-inflated, inversely deltoid or obovoid-deltoid when viewed from above, about as broad as long; coronal processes with 6–8 hairs or hair-rudiments. [PLATE 6, FIGURE 21; PLATE 7, FIGURE 10.]

Low littoral, with *Neomeris Cokeri* and *Acetabulum polyphysoides*, Atwood Cay, Bahamas, *Howe 5311*, December 4, 1907. Only six or seven plants of forma *deltoideum* were found; they were growing intermingled with our *5310* (see PLATE 7, FIGURE 9), which we are referring to *A. polyphysoides* without a distinctive form name, even though the rays are commonly narrower and more pointed than in the Guadeloupe plants. No connecting forms between our *5311* and *5310* were observed and the two are rather strikingly different in habit, but the specimens of the former are infertile and as some of the Guadeloupe representatives of *A. polyphysoides* have a somewhat intermediate appearance, we cannot do otherwise, for the present, than to consider *deltoideum* a form of this species.

## C. A NEW HALIMEDA

### **Halimeda lacrimosa** sp. nov.

Dark gray-green in the younger parts when living, becoming albescent or white with age, soon decumbent, weak and straggling in habit, estipitate, 2–5 cm. in height or length, very strongly calcified, the calcification soon involving the medulla and the entire length of the peripheral utricles; branching irregularly dichotomous or trichotomous, largely but not wholly in a single plane, the nodes in decumbent forms now and then rhiziniferous, or somewhat stoloniferous: segments obovoid, pyriform, or subglobose, occasionally subterete, 1–5 mm. long, 1–5 mm. broad or thick (those near base scarcely different or often a little smaller), solid, firm, and stone-like, or the larger very often more or less hollow or cavernose in the medullary region and easily crushed on drying, the surface compact, smooth, and commonly nitent: peripheral utricles mostly rather obconical, usually somewhat flaring at surface, 40–110 $\mu$ long, 33–37 $\mu$ in average maximum diameter in surface view, truncate or very slightly rounded at apex with apical walls often incrassate, retuse on drying, lateral walls in contact for only $\frac{1}{10}-\frac{1}{30}$ their length but commonly coherent on decalcification: utricles of the subcortical layer in a single series, clavate-capitate, their subglobose or obovoid heads mostly 66–110 $\mu$ in maximum diameter, each bearing 6–18 peripheral utricles: filaments of the central strand fusing in twos, threes, or rarely fours at the nodes, the resulting filaments sometimes again incompletely fused in twos, threes, or fours: sporangia unknown. [PLATE 4, FIGURE 1; PLATE 6, FIGURES 3–11.]

In the Bahama Islands, from near low-water mark down to a depth, at least, of ten or twenty meters: Mariguana (near the Southeast Point), *no. 5524*, type (11 December, 1907, M. A. H.), and *nos. 5492* and *5504*; Great Ragged Island, *no. 5810*; and Ship Channel Cay, *no. 3947*.

A peculiar species, without close affinities among the species of the genus hitherto described. It is apparently more common in the sublittoral or elittoral zone than in the littoral, which perhaps accounts for the rarity with which it has been collected. In respect to the prevailing mode of fusion of the nodal filaments of the central strand, *H. lacrimosa* has most in common with the *H. Tuna* group, although there is sometimes also a secondary incomplete fusion of the fused filaments or perhaps it would be better to say that several or many (6–8 or more) filaments sometimes fuse imperfectly or for a very short distance into one. But in general habit and form, *H. lacrimosa* is little suggestive of *H. Tuna* or of any other *Halimeda* known to us. The subcortical utricles are chlorophylose and as a rule they become readily visible from the exterior after decalcification.

## D. UDOTEA CONGLUTINATA AND UDOTEA CYATHIFORMIS

*Udotea conglutinata* (Ell. & Soland.) Lamour. and *U. cyathiformis* Decaisne have been quite commonly combined by students of the *Codiaceae*, a circumstance that easily is explicable, inasmuch as *Udotea cyathiformis* is often scarcely more cyathiform than *U. conglutinata* and inasmuch as some of the other more obvious ordinarily distinctive characters are subject to a considerable degree of variation. The writer has shared in this misconception, as he now considers it, and has distributed at least one series of specimens of *U. cyathiformis* * to various herbaria as *Udotea conglutinata*. But with added experience with both living and dried specimens, it has become increasingly evident that the *Udotea conglutinata* group in the West Indies embraces at least two species. The Ellis & Solander "types" appear to have been lost, but in view of the only figure of "*Corallina conglutinata*" given by them there can be no reasonable doubt as to which of the two forms was before them, even though their description is not altogether conclusive. The probable type material of *Udotea cyathiformis* Decaisne is represented in the herbarium of the Muséum d'Histoire Naturelle in Paris by two specimens now on one herbarium-sheet but fastened to separate smaller sheets. Below the lower, less cyathiform of the two specimens, is a "Herb. Mus. Paris." label, on which is inscribed in Decaisne's hand, "Udotea Acetabulum D$^{ne}$. Iles des Saintes, près la Guadeloupe. M. D'Avrainville, 1842." The specific name was apparently changed to *cyathiformis* on publication, without a corresponding change in the herbarium label. The two specimens agree essentially with the cyathiform plants from Bemini Harbor, Bahamas, shown in FIGURE 2 of our PLATE 3, which, by the way, were found growing with more numerous plants of *U. conglutinata*, one of which is photographed on PLATE 2 (the largest plant). The plants shown in the upper half of our PLATE 3 are rather strikingly different from the typical *Udotea cyathiformis*; they are, in fact, so *Penicillus*-like in habit that on finding them we were inclined for a time to look upon them as a probably new cyathiform species of *Penicillus*, but on a microscopic examination nothing could be found to distinguish them satisfactorily from the typical *U. cyathiformis.* They were growing on sand-covered rocks at the low-water line, a position that would presumably have been unfavorable to a full and normal development. Specimens from Culebra Island, Porto Rico (*no. 4338* in herb. N. Y. Bot. Garden), apparently bridge over the gap in habit between these short *Penicillus*-like plants and the normal *U. cyathiformis.* The plants from Key West, Florida, figured by W. H. Harvey (Ner. Bor.-Am. 3 : *pl. 40C*) as *Udotea conglutinata* are, with little doubt, *U. cyathiformis*, as would appear from the very distinct longitudinal striations of the flabellum in the natural-size figures and from the rather straight and rigid character of the filaments in the detailed enlargement.

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* *No. 3976*, from the Cave Cays, Exuma Chain, Bahamas.

Photographs of representatives of *Udotea conglutinata* and *U. cyathiformis* are given herewith and below are descriptions and a key which includes the more important diagnostic characters. The characters of the stipe-cortex, which we have illustrated by drawings (PLATE 8, FIGURES 8–13) we have found especially reliable in determining occasional forms whose relationships might otherwise seem a little doubtful.

Flabellum plane; transition from stipe to flabellum gradual; filaments of flabellum 28–60 μ in diameter, interwoven and tortuous, usually forming a superficial tomentulose nap; branches of the corticating filaments of the stipe somewhat loosely and irregularly fastigiate, the ultimate divisions mostly finger-shaped, subacute, or taper-pointed.................. ........ ........................................ *U. conglutinata.*

Flabellum more or less cyathiform or open on one side and almost plane (then usually a little concavo-convex, at least at base); transition from stipe to flabellum abrupt; filaments of flabellum nearly straight and parallel, mostly 60–100 μ in diameter; branches of corticating filaments of stipe compactly cymose-fastigiate, the ultimate divisions scarcely longer than broad, truncate, truncate-obtuse, or commonly with expanded truncate-capitate apices..... *U. cyathiformis.*

UDOTEA CONGLUTINATA (Ell. & Soland.) Lamour. Hist. Polyp. 312. 1816

*Corallina conglutinata* Ell. & Soland. Nat. Hist. Zooph. 125. *pl. 25. f. 7.* 1786.

*Flabellaria conglutinata* Lamarck, Ann. Mus. Hist. Nat. **20**: 301. 1813.

Plants 3–9 cm. high, from a bulbous, subfusiform, or fasciculate-funicular rhizoidal base, light-, yellowish-, or albescent-green, more or less strongly calcified; stipe simple, subterete below, commonly flattened, expanded, and cuneate above, 0.5–3.0 cm. long, mostly 1.5–7.0 mm. wide, corticated, its surface very minutely tomentulose-spongiose or somewhat compact and smooth: transition in structure from stipe to flabellum gradual, the flabellum uncorticated except at the very base, plane, semiorbicular, cuneate-obovate, subreniform, spatulate, or rarely cuneate-ligulate, 1.5–7 cm. long, 0.5–11 cm. wide, subentire, erose-sinuate, or irregularly lobate, rarely with innovating conformable lobes, for the most part distinctly zonate, the base cuneate, cuneate-truncate, or occasionally subarcuate, the surface longitudinally strigose, or commonly spongiose or subvelutinous: filaments of the flabellum interwoven in several or many layers, in most cases forming a superficial tomentulose nap by repeated dichotomies, the ultimate branches usually short, tortuous, and often somewhat divaricate, each filament, except in a very juvenile state, enclosed in a porose calcareous sheath, destitute of lateral branches or appendages, constricted just above the dichotomies and sometimes here and there in intervening parts, rarely subtorulose, 28–60 μ in diameter (decalcified; often larger under a dichotomy); pits of the calcareous sheath rounded or angular, mostly 8–20 μ in diameter; branches forming the stipe-cortex slender, rather flexuous and tortuous, somewhat loosely and irregularly fastigiate, the ultimate divisions mostly finger-shaped, subacute or taper-pointed, 8–19 μ in diameter. [PLATE 2; PLATE 8, FIGURES 11–13.]

TYPE LOCALITY: Bahama Islands.

DISTRIBUTION: Bermuda, southern Florida, and the West Indies.

UDOTEA CYATHIFORMIS Decaisne, Ann. Sci. Nat. II. **18**: 106. 1842

*Udotea conglutinata* Vickers, Phyc. Barbad. **1**: *pl. 32.* 1908; probably also Harvey, Ner. Bor.-Am. **3**: *pl. 40C.* 1858.

Plants 2–17 cm. high, from a bulbous, subfusiform, or fasciculate-funicular rhizoidal base, usually dark- or yellowish-green when living, becoming more or less albescent on drying, moderately calcified and often remaining flexible, or more encrusted with age; stipe simple, mostly subterete, sometimes a little expanded and flattened above, 0.2–5.0 cm. long, 1–6 mm. wide, corticated, its surface compact and smooth: transition in structure from stipe to flabellum abrupt, the flabellum uncorticated, cyathiform, now and then 1–5 cleft nearly or quite to the base, or more often early divided to base on one side and becoming almost plane, but usually remaining more or less concavo-convex at extreme base, then mostly triangular-obovate, subcuneate-obovate, semiorbicular, spatulate, or spoon-shaped, 1–11 cm. long, 1–9 cm. wide, subentire, often becoming irregularly laciniate-fimbriate, rather faintly or occasionally not at all zonate, the surface longitudinally strigose: filaments of the flabellum in several or many layers, nearly straight, parallel and rigid, somewhat flexuous and interwoven, distinct, often suggesting those of *Penicillus*, each enclosed in a porose calcareous sheath, destitute of lateral branches or appendages, constricted just above the dichotomies, 40–135 μ (mostly 60–100 μ) in diameter (decalcified; often larger under a dichotomy), pits of the calcareous sheath rounded or angular, mostly 5–18 μ in diameter; branches forming the stipe-cortex in compact cymose-fastigiate clusters, the ultimate divisions scarcely longer than broad, truncate, truncate-obtuse, or very commonly with expanded truncate-capitate apices, 8–50 μ in diameter. [Plate 3; plate 8, figures 8–10.]

Type locality: Iles des Saintes, near Guadeloupe, West Indies.

Distribution: Southern Florida and West Indies.

## E. A NEW BAHAMIAN UDOTEA

### **Udotea spinulosa** sp. nov.

Plants 7–8 cm. high from a fusiform or fasciculate-funicular rhizoidal base, grayish green, strongly calcified; stipe simple, subterete below, flattened above, 1–2 cm. long, 3–4 mm. wide, corticated, its surface nearly smooth or minutely velutinous-tomentulose: flabellum obovate with a subcuneate base, 5–6 cm. long, 4-6 cm. wide, 0.4–0.6 mm. thick, longitudinally furrowed or striate, not at all or very faintly zonate, rather rigid and brittle when dry, lateral margins subentire, apical margin more or less laciniate and commonly fractured, the surface appearing minutely corrugated or spongiose-velutinous under a lens, becoming compact and nearly smooth toward the base: filaments of the flabellum in 3–7 layers, nearly parallel or flexuose and interwoven, subcylindrical, sparingly dichotomous, strongly constricted just above the dichotomies, 46–84 μ in diameter, enclosed in a non-porose calcareous sheath especially in the outer parts, or irregularly incrusted, the superficial (or the interior wherever they touch the surface) thickly beset externally with short cylindrical, truncate-conical, subturbinate, or obconical processes 16–40 μ in diameter, each crowned with 2–8 acuminate prongs or spines formed by 1–3 close-set dichotomies, these lateral processes (mostly 55–160 μ long, including their spinulose crowns) forming an imperfect kind of cortex; medullary filaments of the stipe 70–110 μ in diameter, the lateral corticating branches 4–6 times dichotomous, their ultimate divisions taper-pointed, mostly 28–200 μ long and 8–24 μ in median diameter. [PLATE 4, FIGURE 2; PLATE 8, FIGURES 1–7.]

Collected on a sandy bottom near low-water mark in Bemini Harbor, Bahamas, *Howe 3272*, April 17, 1904.

*Udotea spinulosa* is most closely allied to *Udotea Palmetta* Decaisne,* but is sufficiently distinguished, we believe, by the thicker (0.4–0.6 *vs.* 0.09–0.16 mm.), more rigid, less zonate flabellum and its subcuneate base, by the larger (46–84 μ *vs.* 8–30 μ), less flattened filaments, which are regularly and strongly constricted above the dichotomies, and by the character of their lateral appendages, which are closely 1–3 times dichotomous instead of simple or once furcate and are 55–160 μ long instead of 11–30 μ, long, the spines crowning a thick stump-like base or pedestal instead of being practically sessile.

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* *Udotea Palmetta* Decaisne was misinterpreted and wrongly described by J. Agardh, who apparently never saw an authentic specimen of it, and his conception of the species has been adopted by most of the later writers who have referred to it, though A. & E. S. Gepp have seen the type specimens and have recently published critical notes upon them (Trans. Linn. Soc. Bot. II. 7: 175. 1908). The type in the herbarium of the Muséum d'Histoire Naturelle in Paris is represented by two plants accompanied by a loose label, on the bottom of which is printed "Herbier Du Petit-Thouars." This label is inscribed in ink "Udotea palmetta D$^{\text{ne}}$, Flabellaria" and "Decaisne scripsit" has been added below in pencil. No locality is given. Decaisne's description was brief, as are also the notes recently added by A. & E. S. Gepp, and the evident types are therefore described in a little more detail below:

UDOTEA PALMETTA Decaisne, Ann. Sci. Nat. II. 18: 105. 1842.

Plants 5.5 cm. high from a subterete or fusiform rhizoidal base, albescent, much calcified throughout; stipe simple, subterete, about 1 cm. long, 1–4 mm. wide, its surface minutely velutinous (nearly smooth under low magnification); flabellum orbicular or obovate, 4.2–4.8 cm. long and of about equal width, 0.09–0.16 mm. thick, rounded or subcordate at base, rather indistinctly and closely zonate (about 16 zones in 4 cm.), plane, longitudinally striatulate, soft and flexible, margins erose or shortly lacerate, the surface appearing strigulose or very minutely pulverulent-punctate under a lens: filaments of the flabellum in 3–5 layers, flexuose and interwoven or somewhat parallel, sparingly dichotomous, sometimes slightly constricted above the dichotomies, 22–30 μ in the major diameter, the superficial more or less flattened laterally (*i. e.* in a plane perpendicular to the surface) and often only 8–16 μ in the minor diameter, all irregularly and amorphously incrusted with lime, crested superficially, wherever they touch the surface, with a single or double usually secund series of simple, geminate or once furcate spines or sharp teeth, these 11–30 μ long, sometimes irregularly curved or subuncinate; medullary filaments of the stipe 19–33 μ in diameter, the lateral corticating branches 2–4 times dichotomous, the ultimate divisions taper-pointed, mostly 27–80 μ long and 8–11 μ in median diameter.

From *Udotea argentea* Zanard., judging by the original description and figures, by a description recently published by A. & E. S. Gepp,* and by American plants which we are somewhat doubtfully identifying with that species, *U. spinulosa* differs in its much thicker, more rigid, less zonate flabellum, which is 3–7- instead of 1- or 2-stratose, in the filaments being constricted above the dichotomies, in their spine-like instead of obtuse, truncate, or capitate appendages, which are secund instead of commonly protruding in all directions, and in the taper-pointed instead of truncate or obtuse ultimate divisions of the stipe-cortex.

From *Udotea conglutinata*, *U. spinulosa* differs greatly in the presence of appendages on the filaments of the flabellum and in the calcareous sheaths of the filaments being non-porose.

From *Udotea Flabellum*, with its strongly marked zonations and highly differentiated cortex, the present species is so widely different that comparison is unnecessary.

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* Trans. Linn. Soc. Bot. II. 7 : 176. 1908.

## Explanation of plates 1-8

### PLATE 1

1. *Neomeris dumetosa.* Photograph of probably authentic specimens now preserved in the herbarium of the Muséum d'Histoire Naturelle of Paris.

2. *Neomeris annulata.* Photograph of fluid-preserved specimens from Bermuda (*Howe 320*).

3. *Neomeris stipitata.* Photograph of fluid-preserved type specimens from Singapore (*Ridley*).

4. *Neomeris van Bosseae.* Photograph of fluid-preserved type specimens from Sikka, Flores, Dutch East Indies (*A. Weber-van Bosse 1196*).

5. *Neomeris mucosa.* Photograph of fluid-preserved type specimens from Atwood (Samana) Cay, Bahamas (*Howe 5308*).

6. *Neomeris Cokeri.* Photograph of fluid-preserved specimens. The four large plants to the left (New Providence, Bahamas, *Howe 3075*) represent an unusually large condition of the species (see Bull. Torrey Club **32**: 580. 1905). The remaining specimens (Atwood Cay, Bahamas, *Howe 5309*) are of the normal form and size.

7. *Neomeris van Bosseae.* Photograph of dried specimens in the Muséum d'Histoire Naturelle of Paris, collected by W. H. Harvey in the Friendly Islands and distributed by him as *Neomeris dumetosa.*

The photographs all represent the plants in their natural size.

### PLATE 2. *Udotea conglutinata*

The largest plant (fluid-preserved) is from Bemini Harbor, Bahamas (*Howe 3240a*); the smallest (dried), at the upper right-hand corner, is from Castle Island, Bahamas (*Howe 5741a*); the remaining (dried) are from Watling Island, Bahamas (*Howe 5237*); all are of the natural size.

### PLATE 3. *Udotea cyathiformis*

1. The more or less *Penicillus*-like (fluid-preserved) plants photographed in the three upper rows are from Cockburn Harbor, South Caicos (*Howe 5547*). Natural size.

2. The five or six (fluid-preserved) plants of the lowest row (Bemini Harbor, Bahamas, *Howe 3240b*) represent the typical form of the species. The middle plant is almost perfectly cyathiform, with, however, a slit down one side of the cup-like flabellum; the plant at the extreme left has a merely concavo-convex or slightly spoon-shaped flabellum and approaches in form certain conditions of *U. conglutinata.* Natural size.

### PLATE 4

1. *Halimeda lacrimosa.* The three larger plants at the left of the photograph, the type specimens, are from the island of Mariguana, Bahamas (*Howe 5524*), where they were dredged in 3 or 4 m. of water; the small plant at the right is from 10 to 20 m. of water on Great Ragged Island, Bahamas (*Howe 5810*). Natural size.

2. *Udotea spinulosa.* Photograph of type specimens (dried) from Bemini Harbor, Bahamas (*Howe 3272*). Natural size.

### PLATE 5

#### 1–14. *Neomeris mucosa*

1. A young stage, with the first four whorls of primary branches.

2. Two members of the fourth whorl of plant shown in Figure 1, showing trimerous branches of the second order.

3. Apical portion of a young plant before the beginning of cortication.

4. A portion of a plant in a similar young stage, showing the widely spaced divaricate or somewhat recurved primary whorls.

5. Five members of a somewhat younger whorl, showing form of the primary branches, their calcification, etc.

6. Parts of two whorls of a later stage, viewed from without, indicating the calcareous sheaths of the primary branches; the branches of the second order have fallen and the ends of the primary branches have to some extent collapsed and drawn away from the enclosing lime-tubes.

7. A portion of the cortex of adult stage in surface view. In the two upper rows the entire surface is calcified except the hair-scars; below, the superficial crust of lime has partly flaked off, leaving the surface of the plant more or less reticulate-alveolate.

8. A primary branch, with sporangium, decalcified.

9. Branches of the first and second orders of adult condition, in lateral view, decalcified, with sporangia; the sketch gives a suggestion of the oblique plane in which each pair of corticating branches lies.

10. A portion of the surface of the adult condition, decalcified, showing form and arrangement of the corticating inflations.

11. A portion of an older part of the cortex, decalcified, showing a less regular form and arrangement of the corticating elements.

12. Two calcified sporangia from the same whorl in proximal view, showing positions of the pedicels of the two corresponding pairs of corticating branches.

13. Parts of two whorls of sporangia, calcified, in distal view, showing their form, mutual relations, and the positions of the pedicels of the corresponding pairs of corticating branches.

14. A part of an adult fertile whorl, the shading indicating the distribution and extent of the calcification.

Figures 1–4, 7–12, and 14 are drawn from the type material (Atwood Cay, Bahamas, *Howe 5308*); 5, 6, and 13 are from *no. 5548* (Cockburn Harbor, South Caicos). Figures 1, 3, and 4 are enlarged 28 diameters; 2, and 5–14, 40 diameters.

15 and 16. *Neomeris stipitata*

15. A primary branch of adult fertile condition, bearing two secondary (corticating) branches, decalcified.

16. One of the not uncommon primary branches that bear three secondary (corticating) branches, decalcified.

Both figures are enlarged 40 diameters.

17–19. *Neomeris van Bosseae*

17. Portion of the decorticated surface of adult plant, showing the tips of the mutually free calcified primary branches. (The tips should be distinctly in pairs more often than the drawing indicates, for the stumps of the broken-off secondary branches often persist and show on the surface as independent tubes).

18. A single primary branch, with its lime-coating.

19. Portions of two primary branches, loosely coherent by the intercalary lime.

Figures 17 and 18 are drawn from the type material (Sikka, Flores, Dutch East Indies, *A. Weber-van Bosse 1196*); 19, from a specimen collected in the Friendly Islands by W. H. Harvey. Figure 17 is enlarged 40 diameters; 18 and 19, 55 diameters.

### 20. *Neomeris dumetosa*

Portion of the decorticated surface of an adult plant, showing the coalescence of the primary branches and intercalary lime-deposits into transverse scales. The figure is enlarged 40 diameters and is drawn from a fluid-preserved specimen collected on the island of Fau, Dutch East Indies, by A. Weber-van Bosse.

## PLATE 6

### 1 and 2. *Neomeris dumetosa*

1. A scale formed by the coalescence of five primary branches and the intercalary lime-masses; from Fau, Dutch East Indies (*A. Weber-van Bosse*).

2. A similar scale from a presumably authentic specimen in the Muséum d'Histoire Naturelle of Paris (see Plate 1, Figure 1).

Figures 1 and 2 are enlarged 55 diameters.

### 3–12. *Halimeda lacrimosa*

3. Utricle of the subcortical layer, bearing six peripheral utricles.

4. Utricle of the subcortical layer, bearing twelve or more peripheral utricles.

5. Utricle of the subcortical layer with about twelve peripheral utricles.

6. Peripheral utricles in surface view, decalcified, the dotted lines indicating the form and position of the utricles of the subcortical layer, which are often clearly visible through the peripheral utricles.

7. Utricle of the subcortical layer of characteristic form, bearing probably twelve peripheral utricles, the latter showing incrassate outer walls.

8. Utricle of the subcortical layer, bearing fourteen peripheral utricles, the latter with only slightly thickened outer walls.

9. Filament from central strand of node, showing complete fusion of two filaments to form one.

10. Filament from central strand of node, showing complete fusion of four filaments to form one.

11. Filament from central strand of node, showing complete fusion of three filaments to form one.

12. Filaments from central strand of node, showing complete fusion of eight filaments to form four which, at their point of origin, are incompletely fused into one.

All the figures are drawn from decalcified type-material (Mariguana, Bahamas, *Howe 5524*). Figures 3–6 and 9–12 are enlarged 40 diameters; 7 and 8, 150 diameters.

### 13–15. *Acetabulum pusillum*

13. Bases of four sporangia from above, showing the coronal processes, each with two hairs or hair-scars.

14. Base of a single sporangium in lateral view, showing coronal process, etc.

15. Base of a sporangium from above, showing the coronal process with three hairs or hair-rudiments.

Figures 13 and 14 are drawn from the type material (Montego Bay, Jamaica, *Howe 5029a*); 15 is from *no. 5453* (Mariguana, Bahamas). All of the figures are enlarged 150 diameters.

### 16–20. *Acetabulum polyphysoides*

16. Base of sporangium from above, showing coronal process with twelve hairs (including rudiments and scars).

17. Bases of sporangia of common form, showing coronal processes with nine and ten hairs (including rudiments and scars).

18. A sporangium-base, similar to that shown in Figure 17, in lateral view.

19. A coronal process with seven hairs (including rudiments and scars).

20. A rare form of coronal process with only five hairs (including rudiments and scars).

Figure 16 is drawn from *no. 5310* (Atwood Cay, Bahamas); 17 and 18 from *no. 5731a* (Castle Island, Bahamas); 19 and 20 from *no. 5312* (Atwood Cay, Bahamas). All of the figures are drawn from decalcified material and are enlarged 150 diameters.

21. *Acetabulum polyphysoides deltoideum*

Coronal process, decalcified, viewed from above, and showing seven hairs (including rudiments and scars). Drawn from the type material (Atwood Cay, Bahamas, *Howe 5311*) and enlarged 150 diameters.

### PLATE 7

1–4. *Acetabulum pusillum*

1. A mature plant, with lime coating.

2. A mature fertile plant, decalcified.

3. A large sterile plant, decalcified. (See Plate 6, Figures 13 and 14.)

4. A large fertile disc with unusually obtuse sporangia, decalcified. (See Plate 6, Figure 15).

Figures 1–3 are drawn from the type material (Montego Bay, Jamaica, *Howe 5029a*); 4, from *no. 5453* (Mariguana, Bahamas). All of the figures are enlarged 16 diameters.

5–9. *Acetabulum polyphysoides*

5. A disc, decalcified, from above, showing twenty-five lightly coherent, obtusely taper-pointed or subrostrate sporangia. (See Plate 6, Figures 17 and 18.)

6. Sporangia from another disc, natural, the shaded areas indicating the distribution of the lime.

7. A disc, decalcified, with seventeen free obtuse sporangia, showing also the corrugated upper portion of the stipe.

8. Sporangia, natural, the shaded areas indicating the extent and distribution of the calcification.

9. More inflated sporangia, decalcified. (See Plate 6, Figure 16.)

Figures 5–7 are drawn from *no. 5731a* (Castle Island, Bahamas); 8, from *no. 5029b* (Montego Bay, Jamaica); 9, from *no. 5310* (Atwood Cay, Bahamas). All of the figures are enlarged 16 diameters.

10. *Acetabulum polyphysoides deltoideum*

A sterile disc, with seven sporangia, decalcified, from above. (See Plate 6, Figure 21.) Drawn from the type material (Atwood Cay, Bahamas, *Howe 5311*) and enlarged 16 diameters.

### PLATE 8

1–7. *Udotea spinulosa*

1. Cross-section of the flabellum, natural. The shading indicates rather too much lime for the medullary portions.

2. Cross-section of the flabellum, decalcified.

3. The tip of a filament from the apical margin of the flabellum, decalcified.

4. Portion of a superficial filament from near the middle of the flabellum, decalcified. The teeth form a part of the surface-covering of the flabellum.

5. A crown of superficial spines from near the base of the flabellum, decalcified.

6. A dichotomy of a flabellum-filament, decalcified, showing the constrictions just above it. (The filaments are somewhat twisted and are viewed a little obliquely.)

7. A crown of spines from the stipe-cortex, decalcified.

All of the figures are drawn from the type material (Bemini Harbor, Bahamas, *Howe 3272*). Figures 1 and 2 are enlarged 40 diameters; 3–7, 150 diameters.

8–10. *Udotea cyathiformis*

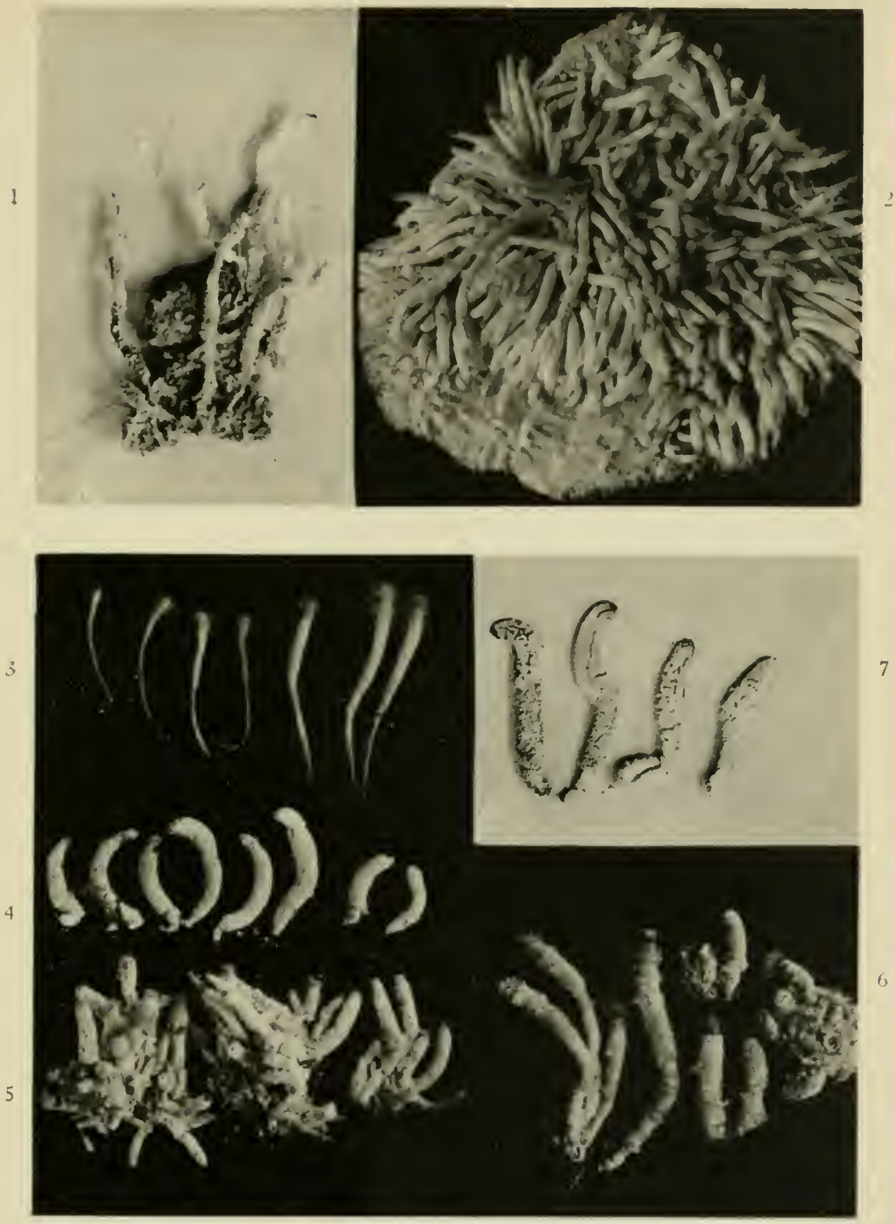
8–10. Ultimate ramifications of the corticating filaments of the stipe.

Figure 8 is drawn from *no. 5547* (Cockburn Harbor, South Caicos, — see Plate 3, Figure 1); 9, from *no. 3976* (Cave Cays, Exuma Chain, Bahamas); 10, from *no. 3240b* (Bemini Harbor, Bahamas — see Plate 3, Figure 2 — filament taken from the lower plant of the two at the left). All the figures are enlarged 150 diameters.

11–13. *Udotea conglutinata*

11–13. Ultimate ramifications of the corticating filaments of the stipe.

Figure 11 is drawn from *no. 3240a* (Bemini Harbor, Bahamas — see Plate 2 — filament taken from the largest plant there shown); 13, from a dried specimen of the same number; 12, from *5237* (Watling Island, Bahamas — see Plate 2 — filament from the plant with the largest rhizoids). All of the figures are enlarged 150 diameters.



1. NEOMERIS DUMETOSA Lamour.
2. NEOMERIS ANNULATA Dickie
3. NEOMERIS STIPITATA M. A. Howe
4, 7. NEOMERIS VAN BOSSEAE M. A. Howe
5. NEOMERIS MUCOSA M. A. Howe
6. NEOMERIS COKERI M. A. Howe

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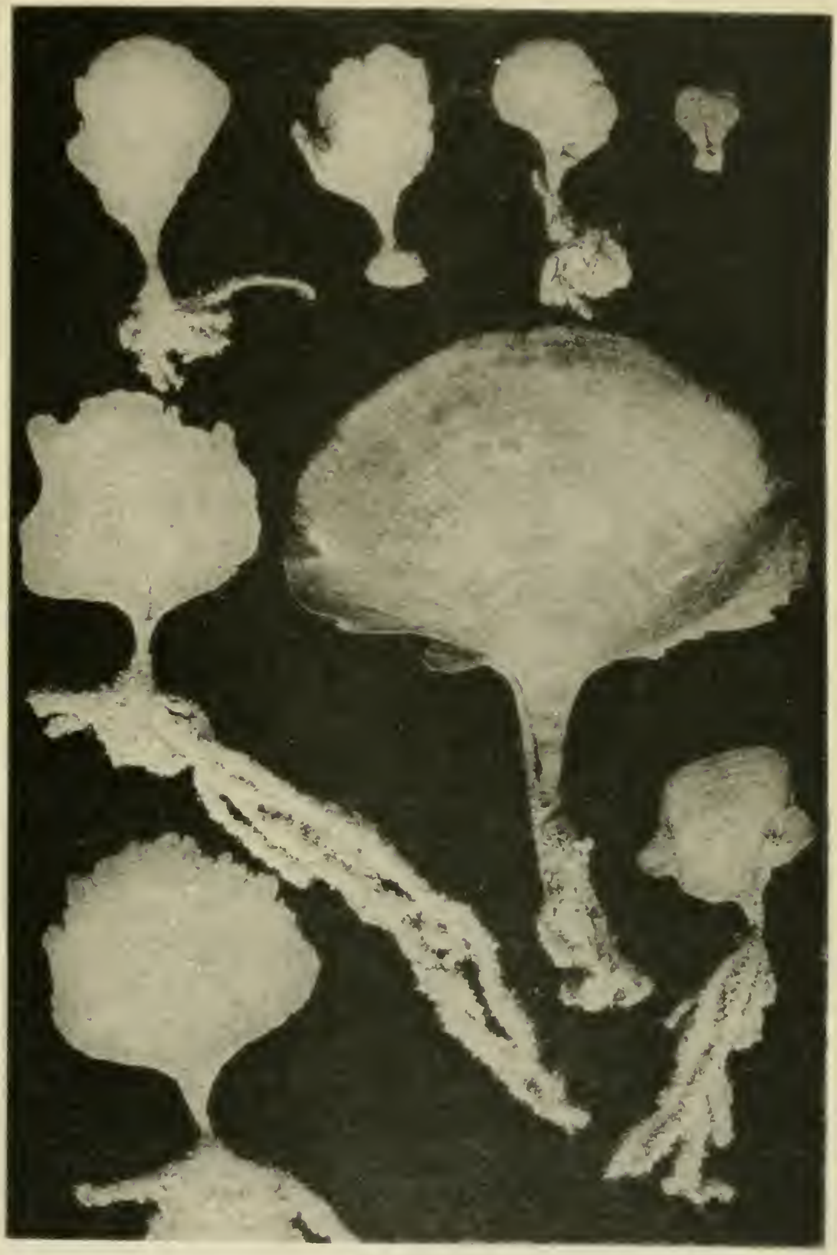

UDOTEA CONGLUTINATA (Ell. & Soland.) Lamour.

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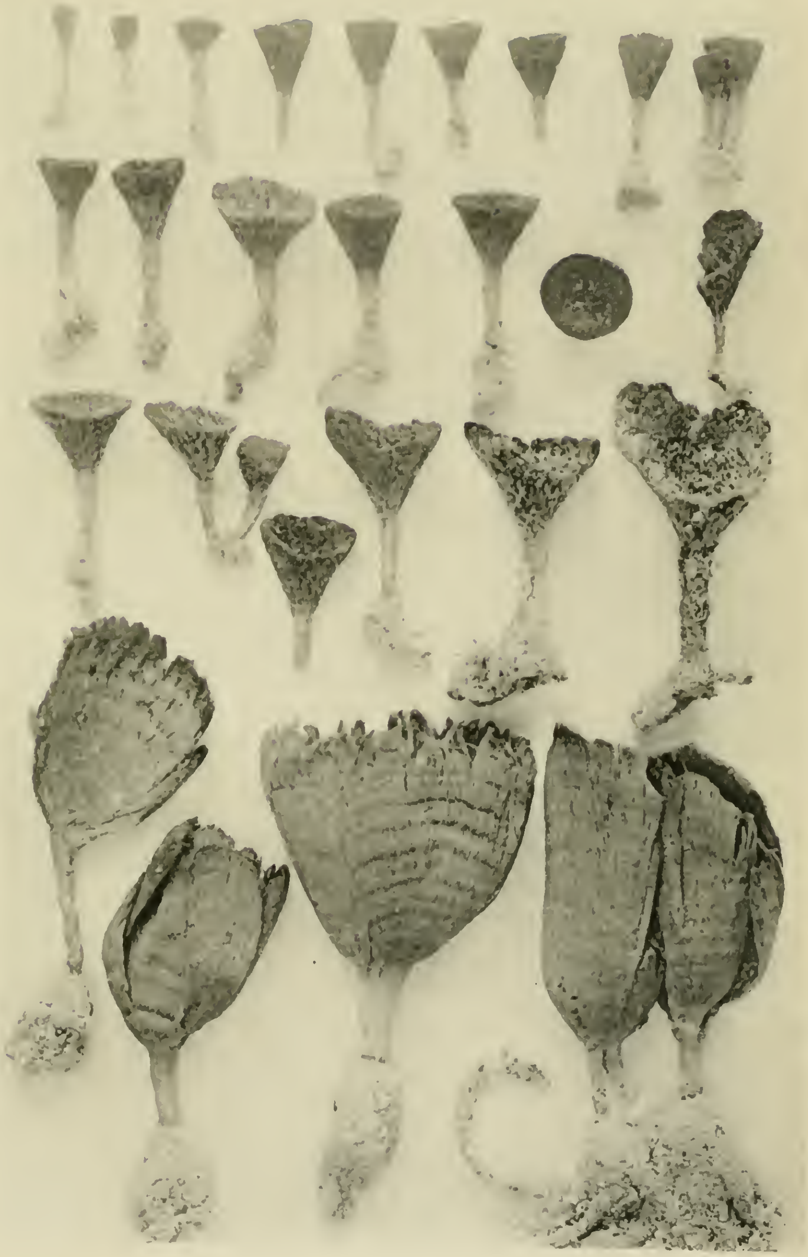

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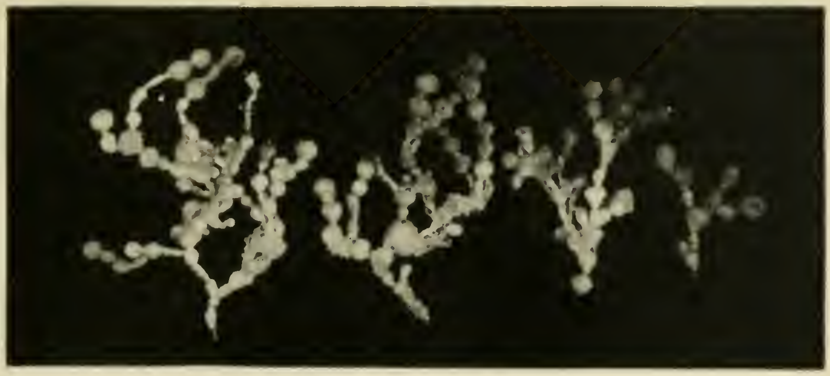

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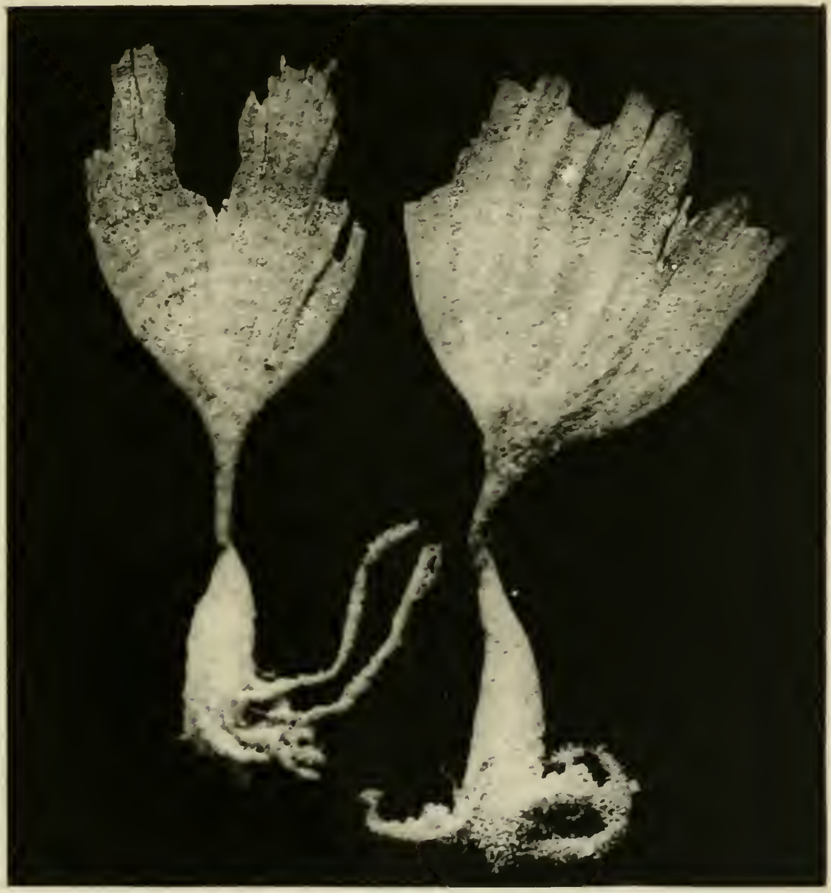
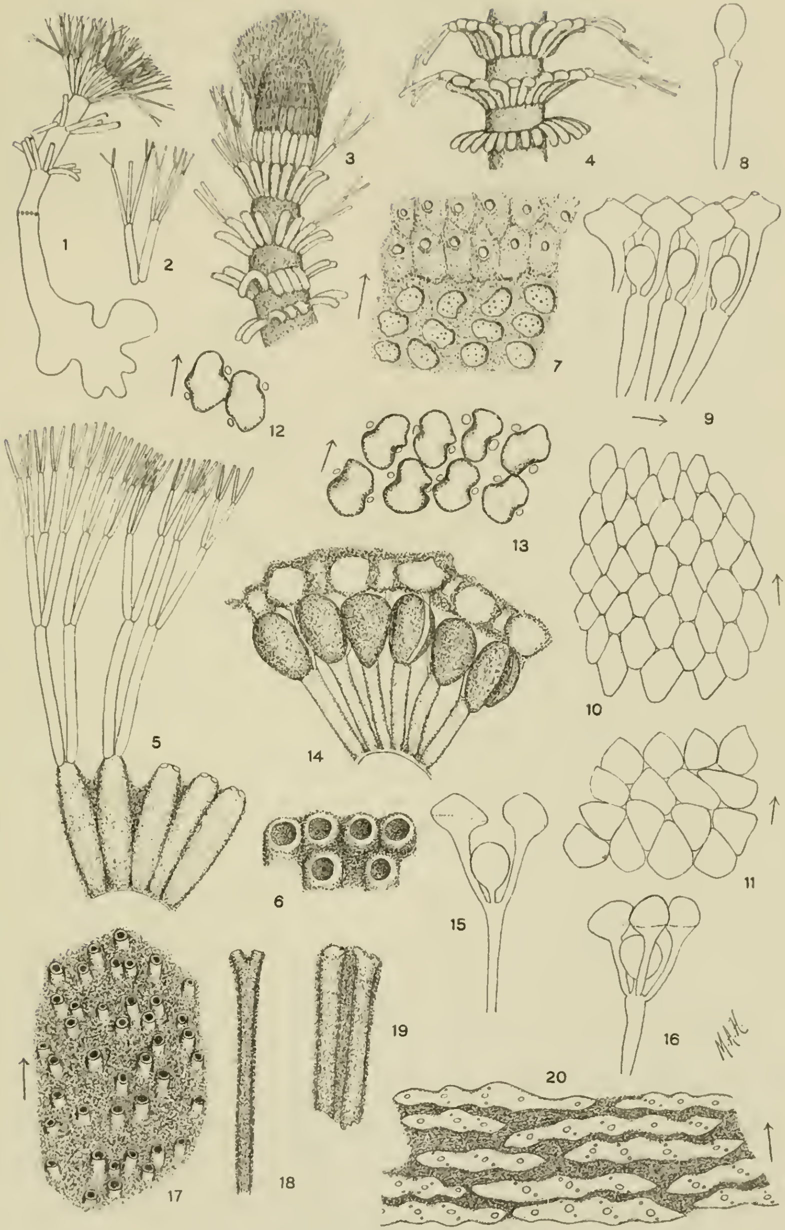


1. HALIMEDA LACRIMOSA M. A. Howe

2. UDOTEA SPINULOSA M. A. Howe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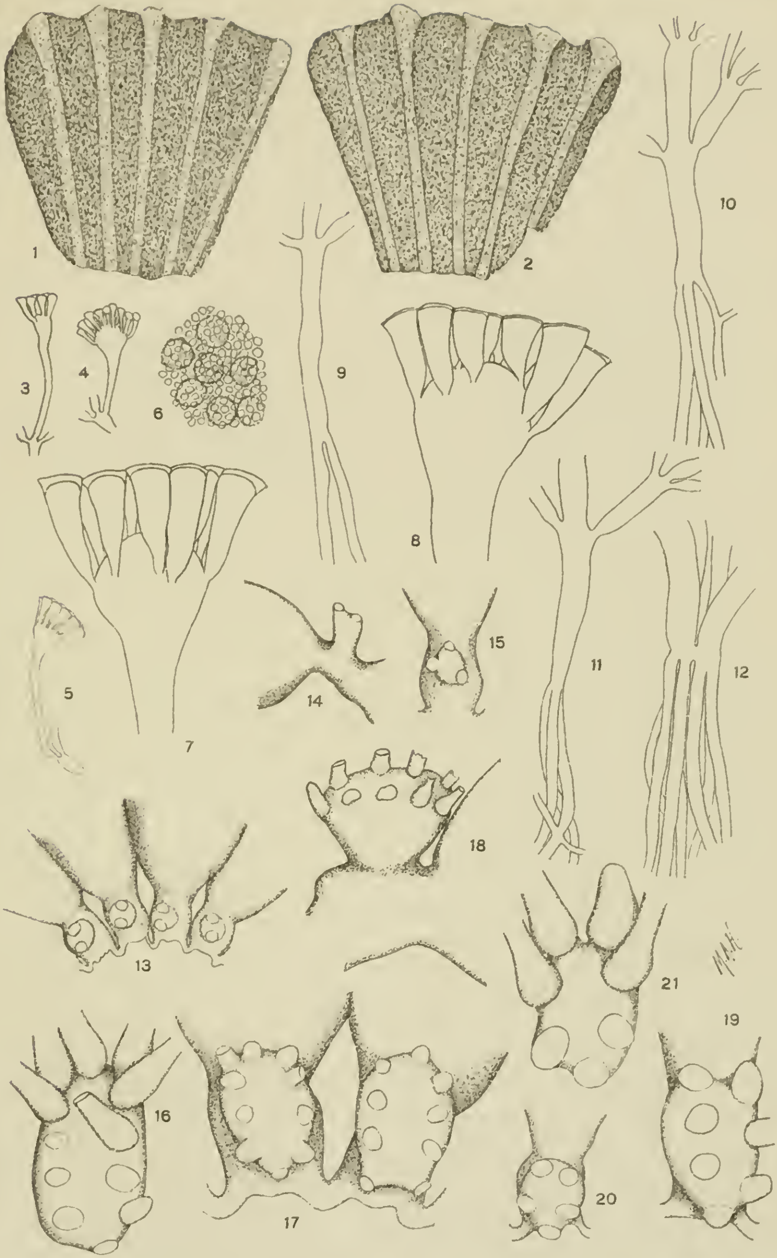
1-14. NEOMERIS MUCOSA M. A. Howe

15-16. NEOMERIS STIPITATA M. A. Howe

17-19. NEOMERIS VAN BOSSEAE M. A. Howe

20. NEOMERIS DUMETOSA Lamour.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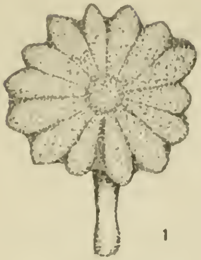
1-2. NEOMERIS DUMETOSA Lamour.
3-12. HALIMEDA LACRIMOSA M. A. Howe
13-15. ACETABULUM PUSILLUM M. A. Howe
16-20. ACETABULUM POLYPHYSOIDES (Crouan) Kuntze
21. ACETABULUM POLYPHYSOIDES DELTOIDEUM M. A. Howe



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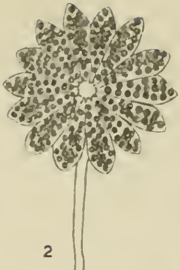

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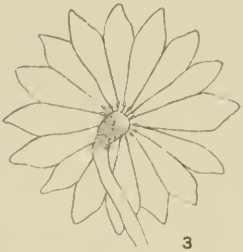

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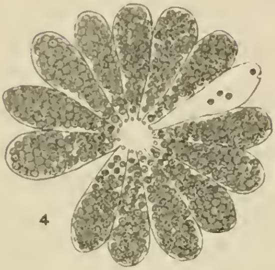

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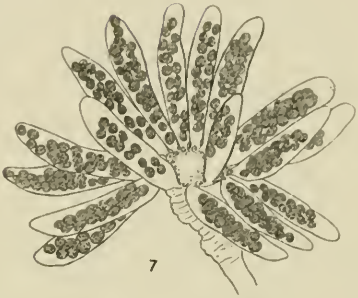

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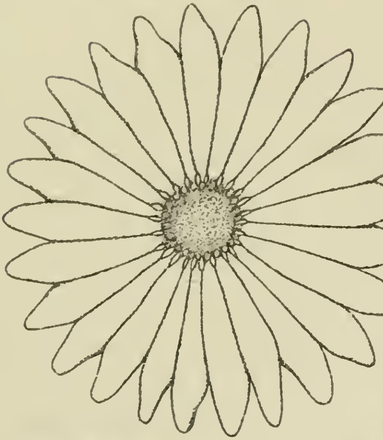

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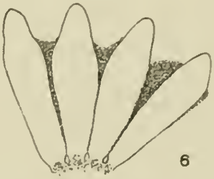

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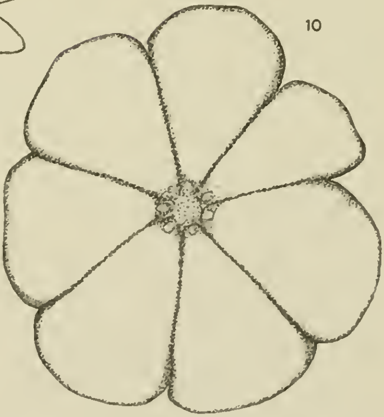

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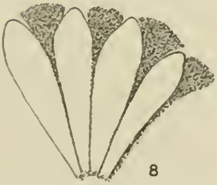

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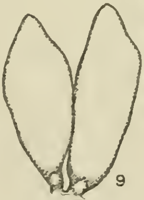

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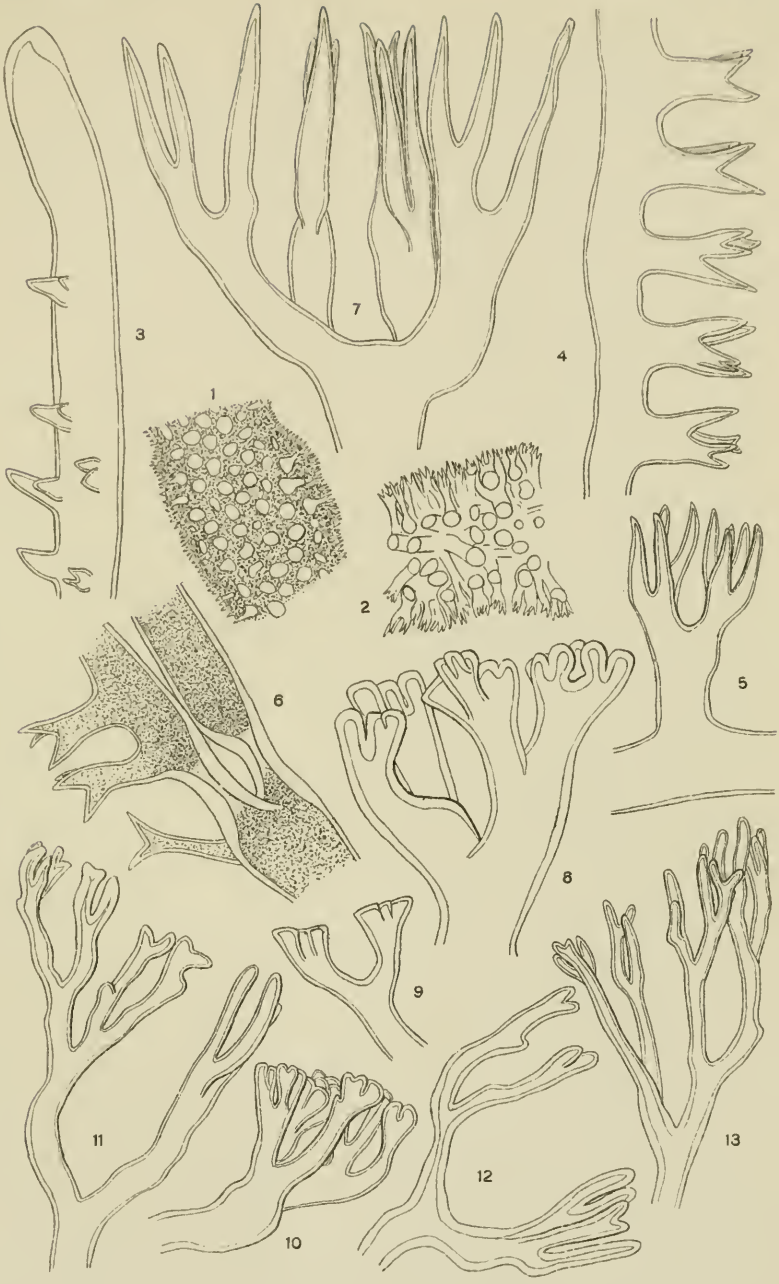
1-4. ACETABULUM PUSILLUM M. A. Howe

5-9. ACETABULUM POLYPHYSOIDES (Crouan) Kuntze

10. ACETABULUM POLYPHYSOIDES DELTOIDEUM M. A. Howe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1-7. UDOTEA SPINULOSA M. A. Howe

8-10. UDOTEA CYATHIFORMIS Decaisne

11-13. UDOTEA CONGLUTINATA (Ell. & Soland.) Lamour.

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# REPRODUCTION BY BUDDING IN DROSERA

By WINIFRED J. ROBINSON

NEW YORK
1909

[Reprinted, without change of paging, from Torreya 9: 89–96. My 1909.]

# REPRODUCTION BY BUDDING IN DROSERA *

In August, 1907, young plants were found growing from old leaves of *Drosera rotundifolia* (Fig. 1) in the propagating houses of the New York Botanical Garden. At first they were thought to be seedlings but further observation showed that they had no cotyledons, no nepionic leaves like those of seedlings, no roots with one exception (Fig. 5), while they bore glandular foliage leaves like those of the adult plant except in size. Hence it was evident that the young plants were produced from the budding of the old tissue. In some cases the leaves upon which they grew were green and apparently normal ; in others, brown and decaying.

Microtome sections through the point of connection between the young plant and the parent tissue (Figs. 2 and 3) showed no union between the vascular tissue of the parent plant and that of the young plant. A differential stain (Haidenhain's iron haematoxylin) showed the difference between the vigorous tissue of the young plant and the disintegrating tissue of the parent plant very clearly, but Delafield's haematoxylin showed no such distinction.

In each case, the stem of the young plant gave rise to five or six leaves before the root appeared as a lateral outgrowth. The root had a red apex and was diageotropic until it had passed beyond the margin of the old leaf, when it bent downward into the sphagnum in which the original plants were growing. In one case only (Fig. 5) was a root observed on the under (non-glandular) surface of the leaf. Later, leaf-petioles and one flower-stalk (Fig. 6) that had accidentally been broken from a plant were found to be proliferating in a similar way.

This growth from an inflorescence is noteworthy because so

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* Illustrated with the aid of the Catherine McManes fund.

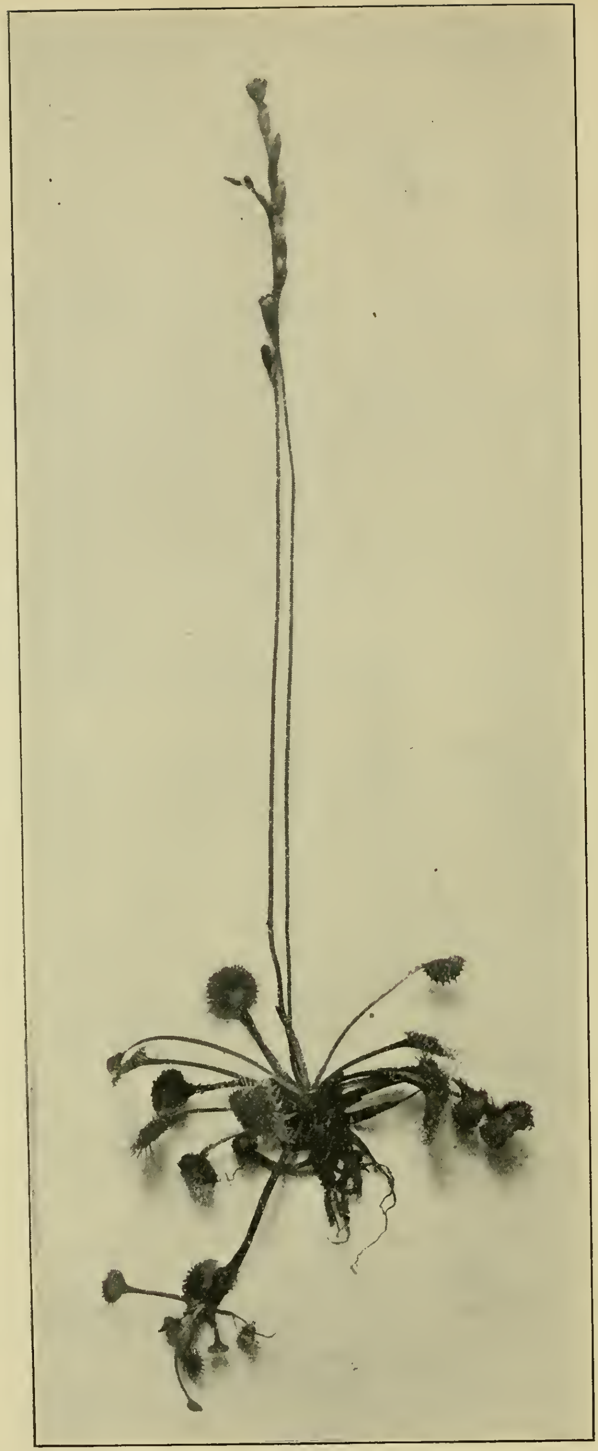

FIG. I. *Drosera rotundifolia*, showing a young plant growing from leaf.

few examples have been reported (Kupfer, Mem. Torr. Bot. Club **12**: 224. 1907; Robinson, Plt. World **8**: 131. 1905). Planchon (Ann. Sci. Nat. III. **9**: 84. *pls. 5 and 6.* 1848) described and figured flowers of *Drosera intermedia* which had passed into a chloranthic condition. The petals and the valves of the ovary were provided with stipules, bore glands, and were circinate in vernation. Leavitt (Rhodora **7**: 14. 1905) described a similar

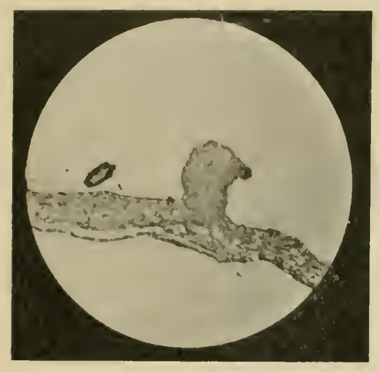

FIG. 2. Photomicrograph of section through an old leaf in region from which young plant is developing.

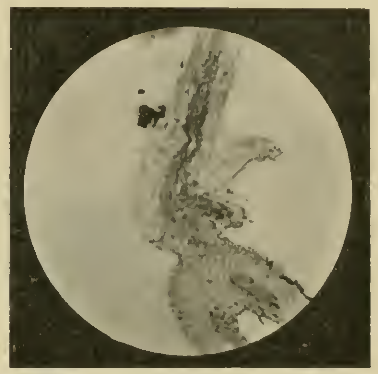

FIG. 3. Photomicrograph of section through a leaf petiole which bears a well differentiated plantlet. There is no connection between either of the vascular bundles of the petiole and the vascular tissue of the young plant.

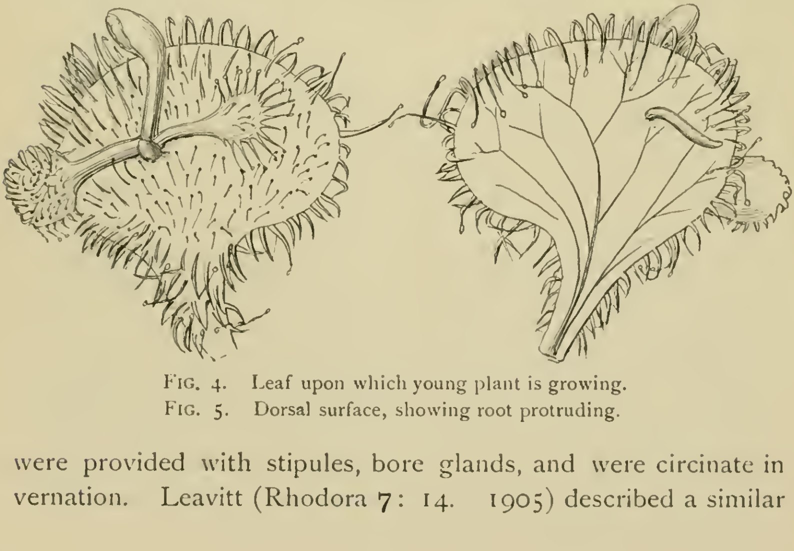

FIG. 4. Leaf upon which young plant is growing.
FIG. 5. Dorsal surface, showing root protruding.

aberrant form of *Drosera rotundifolia* but neither observer recorded the development of young plants from the flower-stalks.

To determine whether it was necessary that a leaf should be in connection with the parent plant in order to proliferate, two leaves cut from a mature plant were placed on sphagnum in a moist chamber September 7. One month later a bud was seen upon the surface of one leaf. Three months from the date of beginning the experiment (Dec. 3) the parent leaf was still green, the leaflets of the young plant were like those of the adult, except in size, and the internodes of the stem were proportionately long, but no root had developed. At the end of four months (Jan. 3) a root was observed which had grown laterally from the base of the stem, while the parent leaf had entirely decayed. This was repeated with four leaves with practically the same results. A portion of a leaf was able to produce a new plant as readily as an entire leaf. Leaves placed with the gland-bearing surface downward in the moist chamber did not produce buds, and all the buds which appeared upon leaves still attached to a plant were upon the upper or ventral side of the leaf.

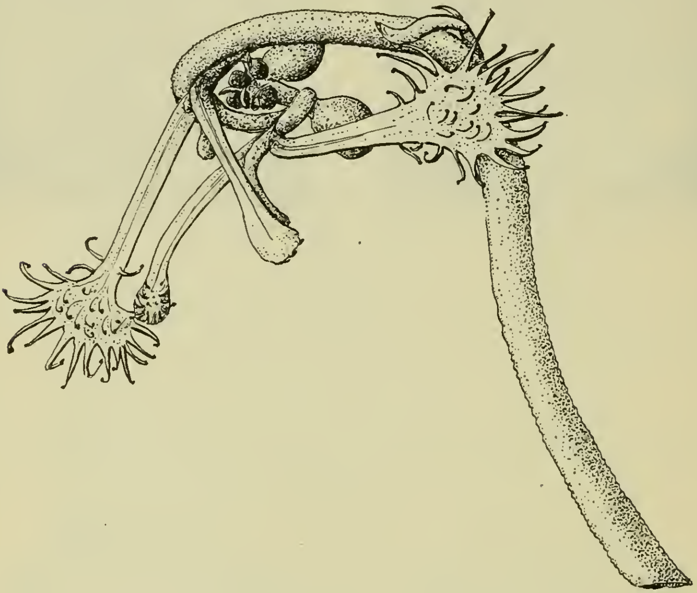

FIG. 6. Flower stalk from which two young plants are growing.

Nitschke (Bot. Zeit. **18** : 57. 1860) described reproduction by budding in plants of *D. rotundifolia* growing in their native bogs. He observed that while the bud-formation from the leaf surface occurred throughout the summer it was especially frequent in the fall. The buds always developed from the upper side of the leaf. He compared the plant arising from the bud with the seedling and noted that the bud-plant had only a stem-root while the seedling had numerous roots at the base. The first leaves of the bud-plant resembled the mature leaves while the seedling had cotyledons each with a single stoma, and nepionic leaves without glandular hairs. Both the bud-plant and the seedling were caulescent during their first year's growth and attained their rosette form at the beginning of the second season, though bud-plants produced in spring in some cases gained the rosette form during the summer. The first leaves made an acute angle with the stem but the angle made by succeeding leaves increased until it became 90°. and the rosette form was reached. Drought tended to hasten the production of the rosette form, while fully developed plants placed under moss produced elongated axes like those of their early form.

Grout (Am. Nat. **32** : 114. 1898) noted adventitious buds on the leaves of *D. rotundifolia*, also the occurrence of glandular hairs a short distance from the base of stems of young plants. The latter observation corresponds with a statement made in Nature (**15** : 18. 1876) that plants of *D. rotundifolia* exhibited at the Chester (England) Society of Natural Science showed elongated axes which produced leaves and glandular hairs alternately.

Similar proliferation of the leaf tissues of *D. intermedia* was recorded by Naudin (Ann. Soc. Nat. II. **14** : 14. *pl. 1. f. 6.* 1840). Two plants developed between the mid-vein and margin of the leaf which had rosettes of leaves like those of the mature plant. The lower surface of the budding leaf was perfectly intact and there was no indication of a root.

The appearance of buds upon leaves of *D. longifolia* was reported by Kirschleger (Bull. Soc. de France **2** : 723. 1855).

Winkler (Ber. d. Deutsch. Gesell. **21** : 105. 1903) noted reproduction in *D. capensis* as arising not from latent embryonic tissue but from ordinary epidermal cells at the apex or near the petiole of the leaf, or upon the petiole itself.

Goebel (Einleit. i. d. exp. Morph. d. Pflanz. 196. *f. 97*. 1908) describes and figures a portion of a leaf of *D. binata*, a species whose leaves fork into two long segments. f a part be cut away and placed in a moist chamber it develops adventitious shoots, which have leaves like those of *D. rotundifolia* instead of being like the parent plant in form. This is the only species so far observed, in which young plants which arise by proliferation from mature tissue, develop leaves different from those of the adult. The question arises as to whether *D. rotundifolia* is not near to the antecedent form in structure while *D. binata* may be the result of the greatest modification, so that it is still in a state of variation and hence reverts to the *D. rotundifolia* type.

An allied form of reproduction which occurs in *D. pygmaea*, a native of southern Australia and New Zealand, is described by Goebel (Flora **98**: 324. 1908). The leaves are arranged in a rosette like those of other species but they are peculiar in having a peltate form and little chlorophyll, the work of assimilation being carried on chiefly by the petioles which are fleshy, contain much chlorophyll, and have stomata. At the close of the vegetative period, in the latter half of October in cultivated plants, numerous brood-bodies which resemble the gemmae of *Marchantia* appear in the center of the rosette. Each is borne upon a slender hyaline stem, the turgid cells at the apex of which set up such a tension that the brood-bodies are easily broken off by the animals which pass over them or by the rain. These small (0.730 mm. by 0.515 mm.), heart-shaped brood-bodies show dorso-ventral differentiation, the under side being smooth while the upper side is rounded into a horse-shoe-shaped cushion. There are stomata on both sides and a vascular bundle runs from the point of attachment to the center of the brood-body. The tissues are rich in starch, fat, and other reserve foods. The anlage of the new plant lies in the hollow at the base and may develop immediately after separation from the parent plant if conditions are favorable, drought being the most serious hindrance. The first leaves are peltate like those of the adult while the nepionic leaves of the seedling are simpler in form. Goebel believes that the origin of the brood-body is from a leaf anlage which explains their appearing alternately with the foliage-leaves, also the development of a slender vascular strand. It is more difficult to correlate particular parts. At first one is inclined to homologize the blade of the foliage-leaf with the brood-body and the petiole of the foliage-leaf with its stem. However the petiole of the leaf is more strongly developed than the blade, while the stem of the brood-body is less developed. Stipules which appear very early in the formation of the leaf have no homologue in the brood-body. The foliage-leaf is curved so that the apex is directed inwards while the brood-body remains upright. The brood-body develops early from the leaf-anlage and its stem must be regarded as a new structure, the function of which is the dissemination of these reproductive bodies. The part homologous with the foliage-leaf is a group of cells which arises on the inner side of the anlage. No axial buds have been observed in the inflorescence of *D. pygmaea* so it seems reasonable to regard the brood-bodies as new structures which do not arise from axial buds.

From the above observations it is seen that reproduction by budding occurs in *D. rotundifolia*, *D. intermedia*, *D. longifolia*, *D. binata*, and if the brood-bodies of *D. pygmaea* be taken as aborted leaves, the reproduction is by budding in that case also. In each species except *D. binata* the first leaves of the young plant resemble those of the adult. In *D. rotundifolia* at least, the resulting form is the same whether the young plant arises from a leaf still attached to the plant, a leaf cutting, or a flower-stalk removed from the plant.

Whether this is regarded as regeneration or not, depends upon the definition of regeneration which is accepted. Morgan (Regeneration, 23. 1901) says, "The word Regeneration has come to mean in general usage not only the replacement of a lost part but also the development of a new, whole organism, or even a part of an organisn, from a piece of an adult, or of an embryo, or an egg." Goebel (Einleit. i. d. exp. Morph. d. Pflanz. 136. 1908) expresses his idea of regeneration as the phenomenon of completion or restoration of a plant body after injury without regard to the manner in which it occurs. Pfeffer (Phys. of Plts. trans. by Ewart, **2**: 167. 1903) states that "only those cases ought to be designated as regeneration in higher plants in which the new parts formed after injury or loss exactly resemble in number and position the organs that have been removed." McCallum (Bot. Gaz. **40**: 98. 1905) recognizes three forms of regeneration as follows: "(1) The part removed is entirely restored by the growth of cells immediately below the cut surface; (2) there is no growth of embryonic tissue at the wounded surface, but at a greater or less distance from it the organization of entirely new primordia which develop organs which replace those removed; (3) the organ removed is restored by the development of already existing dormant buds." Dr. Kupfer (Mem. Tor. Bot. Club **12**: 196. 1907) says "The word regeneration ought to be limited to those cases in which an organ is formed, *de novo*, at a place or under conditions in which it would not normally be formed."

In the broadest sense of the term this form of reproduction in *Drosera* may be termed regeneration, but since it may occur on portions of the plant which are still attached to the main axis, without the apparent stimulus of injury, it seems better to place it in the category of plants that reproduce by budding than as an example of regeneration. However it is an illustration of a principle which much of the work on regeneration teaches, that the different forms of reproduction in plants may be arranged in a scale of slight gradations.

WINIFRED J. ROBINSON

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CONTRIBUTIONS FROM THE NEW YORK BOTANICAL
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# NOTES ON NORTH AMERICAN HYPOCREALES-II. NECTRIA PEZIZA

By FRED J. SEAVER

NEW YORK
1909

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# Notes on North American Hypocreales — II. Nectria Peziza*

FRED J. SEAVER

(WITH PLATE 15)

*Sphaeria Peziza* was described by Tode in 1791, and while there is probably no type specimen in existence, the illustrations and descriptions by Tode seem, from our observations, quite definitive of the species. While many species of the present and closely related genera cannot be distinguished except by a close microscopic study of the spore-characters, thus rendering illustrations of gross characters, only, valueless, this is not true of the one here treated. Having observed and studied this species for the past five years in the field, covering an extensive range of locality, we find that there are few members of the genus, if any, which are more easily recognized on external characters. Add to this, on microscopic examination, the broadly-elliptical, septate, non-constricted spores with a distinct oil-drop in each cell, and the species would seem to be very well marked.

This is probably one of the most common and widely distributed species of non-stromatic *Nectria*, and, as is usually the case with species which are common and subject to more or less variation, has been much studied, greatly misunderstood, and many times redescribed. The perithecia in this species are large, compared with those of other species of the genus, ranging from one third to one half millimeter in diameter and nearly globose, especially when moist, with the ostiolum only slightly prominent. The color is from pale to deep orange, becoming deeper on drying, but often fading with age to very pale yellowish or whitish. The plants are usually widely scattered but occasionally crowded, giving somewhat the appearance of a stromatic form, but no true stroma is present. The perithecia produce no well-developed hairs but are often clothed with a growth of mycelial threads, which character seems to vary with conditions. Specimens collected in good condition are nearly smooth but become more or less roughened with age. The variation is not great but is sufficient to have led to some confusion. The perithecia at maturity, especially when dry, almost invariably collapse from the top, becoming cup-shaped and in this condition very much resemble a *Peziza*, which fact has doubtless suggested the specific name. This latter character has been the cause of considerable confusion.

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* Notes on North American Hypocreales — I, appeared in Mycologia 1: 19-22. *pl. 2.* 1909.

Most of the American specimens examined by Mr. Ellis have been referred by him to *Nectria vulpina* (Cooke) Ellis & Everh., while most of the foreign specimens examined by the writer have been referred by various authors to *Nectria Peziza* (Tode) Fries, but notwithstanding this fact close study of American and foreign material fails to reveal any difference. *Nectria vulpina* (Cooke) Ellis & Everh. was based on material collected at Newfield, New Jersey, and was first described by Mr. Cooke as a *Peziza*, a mistake which is likely to be made on account of the close resemblance of these plants to some of the cup-fungi. The species was later transferred to the genus *Dialonectria* by Mr. Cooke and still later to the genus *Nectria* by Saccardo, and still retained as a distinct species, although there was no reliable character by which it could be distinguished from the commonly recognized species *Nectria Peziza* (Tode) Fries. A specimen in the Ellis collection which is evidently cotype material of *Nectria vulpina* (Cooke) Ellis & Everh. has been closely studied with the hope of discovering some character by which it might be distinguished from *Nectria Peziza* (Tode) Fries, but except for a very slight variation in the size of the spores this is a typical specimen of the latter species, as are the other specimens in the same collection referred to this name.

*Nectria betulina*, which was described from American material, seems to be a form of the present species which occurs in cracks and crevices of bark, and, the perithecia becoming crowded, presents the appearance of a stromatic form. The perithecia and spores are typical of *Nectria Peziza* (Tode) Fries and I am unable to separate it from that species. *Nectria rimincola* Cooke is a similar form. I give below a complete synonymy and description of *Nectria Peziza* (Tode) Fries, based on our own study :

NECTRIA PEZIZA (Tode) Fries, Summa Veg. Scand. 388. 1849

*Sphaeria Peziza* Tode, Fungi Meckl. **2**: 46. 1791.

? *Peziza hydrophora* Bull. Hist. Champ. 243. 1809.

*Peziza Dasyscypha vulpina* Cooke, Hedwigia **14**: 82. 1875.

*Nectria rimincola* Cooke, Grevillea **11**: 108. 1883.

* *Nectria lasioderma* Ellis, Am. Nat. **17**: 194. 1883.

*Dialonectria vulpina* Cooke, Grevillea **12**: 83. 1884.

*Nectria Umbellulariae* Plow. & Hark. Bull. Calif. Acad. Sci. **1**: 26. 1884.

*Nectria vulpina* Ellis & Everh. N. Am. Pyrenom. 103. 1887.

*Nectria betulina* Rehm, Ann. Myc. **3**: 519. 1905.

Perithecia superficial, scattered, gregarious or occasionally crowded, globose or subglobose, usually collapsing from the top and becoming pezizoid, at first clothed with a scant covering of delicate, white, mycelial threads (no true hairs) which disappear with age, leaving the perithecia smooth or in very old specimens slightly rough and furfuraceous, 250–500 μ in diameter (mostly about 300 μ), varying in color from pale to deep orange, color darker in dried specimens, weathered specimens fading to pale yellow; ostiolum minute, in young specimens just visible and in older forms depressed and inconspicuous; asci cylindrical or clavate, 8-spored, 50–75 μ × 5–8 μ; spores broadly elliptical, obliquely 1-seriate or becoming crowded and partially 2-seriate, thick-walled, 1-septate, not constricted, with 1 large, conspicuous oil-drop in each cell, 10–14 μ × 4–6 μ (mostly 10 × 5 μ); paraphyses short, branched, not conspicuous. [PLATE 15.]

On decaying decorticated wood, more rarely on bark, fungi, and old hemp cloth.

TYPE LOCALITY: Mecklenburg, Germany.

DISTRIBUTION: New York to Ontario, North Dakota, California, and Louisiana.

ILLUSTRATIONS: Tode, Fungi Meckl. **2**: *pl. 15. f. 122;* Bulliard, Herb. France, *pl. 410. f. 2;* Currey, Trans. Linn. Soc. **22**: *pl. 57. f. 44;* Berkeley, Outl. Brit. Fung. *pl. 24. f. 6;* Greville, Crypt. Fl. **4**: *pl. 186. f. 2.*

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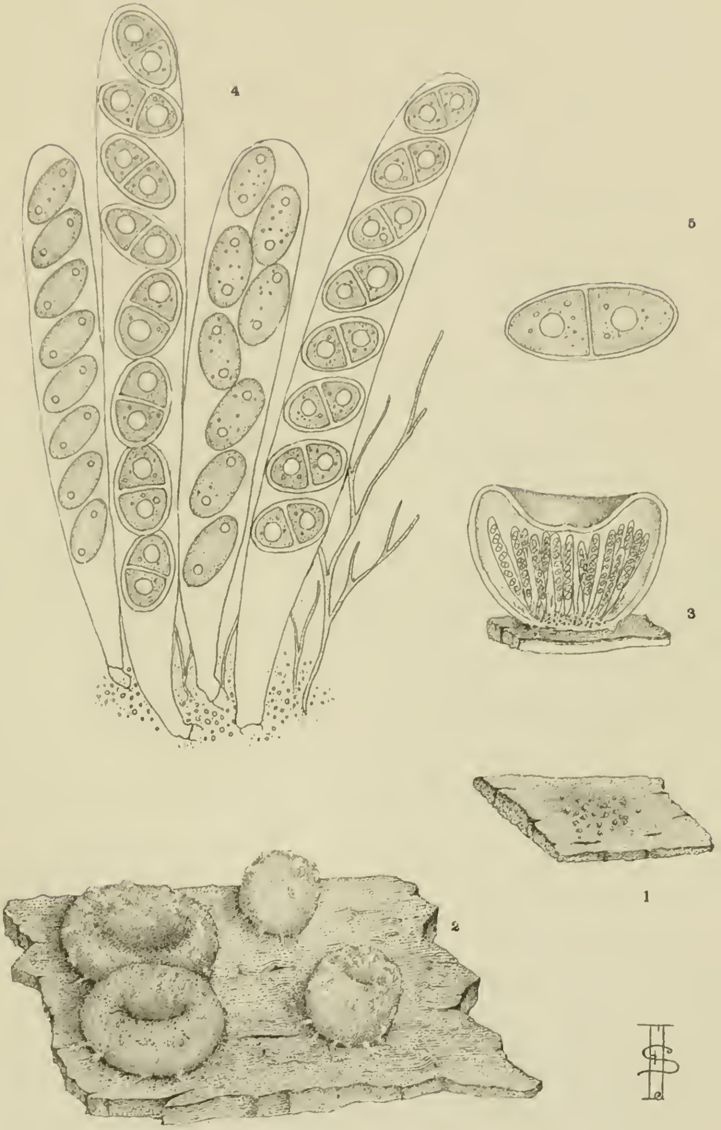
* The type of this species in the Ellis collection is so scant that scarcely a perithecium in good condition could be found, and it is impossible to make a thorough study of gross characters. The spores are typical of the above species.

EXSICCATI: Ravenel, Fungi Am. Exsicc. *644;* Ellis, N. Am. Fungi *774;* Wilson & Seaver, Ascom. and Lower Fungi 16. Other specimens examined: California, *Harkness;* Iowa, *Arthur, Seaver;* Louisiana, *Langlois*; Maine, *Harvey;* New York, *Atkinson, Brown, Seaver;* North Dakota, *Seaver* (various collections); New Jersey, *Ellis* (various collections); Ohio, *Hawkins, Morgan;* Ontario, *Dearness, Macoun.*

### Explanation of plate 15

1. Cluster of plants, natural size.
2. Several plants, × 50.
3. Diagram section of plant, × 50.
4. Cluster of asci, × 1200.
5. One spore, × 2500.



NECTRIA PEZIZA (Tode) Fr.

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CONTRIBUTIONS FROM THE NEW YORK BOTANICAL GARDEN—No. 123

# EXPERIMENTS UPON DROSERA ROTUNDIFOLIA AS TO ITS PROTEIN-DIGESTING POWER

By Winifred J. Robinson

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# EXPERIMENTS UPON DROSERA ROTUNDIFOLIA AS TO ITS PROTEIN-DIGESTING POWER

By Winifred J. Robinson

A repetition, with some extensions, of a part of Darwin's exhaustive series of experiments on the digestive power of the leaves of *Drosera rotundifolia* was undertaken with the purpose of ascertaining whether the purer proteins now available would give any different results from those obtained by Darwin with tissue fragments or crude protein materials, solid and liquid. The experiments were carried on at the New York Botanical Garden under the direction of Professor William J. Gies, of the College of Physicians and Surgeons of Columbia University.

The plants used were collected in the bogs near Lakewood, N. J., in July, 1907. They were planted in sphagnum at the propagating house of the New York Botanical Garden, where they were kept continuously except when certain of their number were brought to the laboratory of the garden for a short time for observation.

The proteins used were prepared at the College of Physicians and Surgeons under the direction of Professor Gies with the exception of the nucleoprotein, which was extracted from compressed yeast by Professor Gies's method, in the laboratory ot the New York Botanical Garden.

To insure accuracy in the records of the experiments a diagram of the arrangement of the leaves of the plant was made in each case, the point on a leaf where a protein particle was placed being indicated on the diagram by an ink spot. Observations of the plants brought to the laboratory were made at intervals of from ten to thirty minutes during the first half day, while those allowed to remain in the propagating house were examined daily.

### DRY EGG-WHITE *

Particles of dry white of egg were placed upon all the leaves of a plant on October 13, 1907. The tentacles curved slowly but at the end of 24 hours were tightly closed over albumen particles. At the end of three days the albumen had entirely disappeared and was no doubt pretty thoroughly digested.

In the use of such crude products as egg-white, as was the case in practically all of Darwin's *Drosera* experiments, the possible influence of salts and other non-protein compounds in the materials employed, is ignored. In the remaining experiments, accessory substances, such as inorganic salts and extractives, have had no influence, for they were completely eliminated from the protein samples in the course of their preparation.

### ACIDALBUMIN

Acidalbumin particles were placed upon all the leaves of a plant on October 13, 1907, but the response was slight, and the albuminate remained at the end of three days.

### ALKALI ALBUMINATE

Alkali albuminate particles were placed upon the leaves of a third plant, October 13, 1907, with a result similar to that in the case of the acidalbumin.

The results of the foregoing experiments show that egg albumen causes a response of the tentacles and ultimate digestion, while the acidalbumin and alkali albuminate both cause a much less vigorous response. The plants upon which the experiments were tried were just ready to enter the resting stage so it is hardly fair to say that they would not more readily digest the acidalbumin and alkali albuminate if the plants had been in prime condition. It is possible, of course, that the prior separation of saline matters and other impurities from the albuminates, removed an effective digestive stimulus.

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* This was the only crude product employed. All others were chemically pure.

### EDESTIN

Particles of crystalline edestin were placed on each leaf of a single plant on October 13, 1907. The response of the plant was very slow, and at the end of 24 hours the edestin granules showed no apparent change. Gradually, however, they were dissolved and at the end of three days had disappeared.

### FIBRIN

Small shreds of fibrin * were placed upon a leaf August 26, 1907, at 2:30 P. M., the plant being kept in the laboratory under a bell-jar, with tubulure, for observation. At the end of 4 hours the tentacles had curved inward and, after 19 hours had elapsed, the particles had been carried from the margin to the center of the disc. At the end of 67 hours a part of the fibrin remained, with the tentacles still slightly closed over it.

On August 26, 1907, small shreds of fibrin were placed on one leaf of each of three plants, which were left at the propagating house; 24 hours later the tentacles were tightly closed over the fibrin in each case. They remained closed through the second day, when they expanded fully. The fibrin had been partially dissolved. Some of the tentacles on two of these leaves were closed over insects. Fibrin was then placed upon the other tentacles, and these continued to be closed after those which digested the fibrin had expanded again.

In an experiment begun October 13, 1907, shreds of fibrin were placed on all the leaves of one plant; 24 hours later the response was slight but at the end of 3 days the fibrin had dissolved.

The results of these experiments show that fibrin, as pure as it can be prepared by the best methods, is dissolved and digested when placed upon leaves of *Drosera rotundifolia.*

### TENDOMUCOID

Small particles of tendomucoid were placed upon two leaves of the same plant, September 18, 1907, and soon dissolved, the glistening drop of solution remaining some time upon the leaf.

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* Given special care in purification. Ash content was only 0.4 per cent.

On September 23 the experiment was repeated with similar results.

On October 13 the experiment was again repeated. This time the plant was kept in the laboratory under a bell-jar, with tubulure, and the drop of dissolved mucoid disappeared, hence it was inferred that digestion had occurred at the end of three days.

### YEAST NUCLEOPROTEIN

September 10 particles of yeast nucleoprotein were placed upon a leaf of a plant in the laboratory. The tentacles slowly closed over it and remained closed three days.

On September 11 the experiment was repeated with the difference that the nucleoprotein was moistened with distilled water before it was used. The result was like that of the preceding experiment. The nucleoprotein became dark-colored in each experiment before it disappeared.

From the response of the tentacles and the disappearance of the nucleoprotein it was inferred that digestion had slowly taken place.

### TENDOCOLLAGEN

Fragments of collagen fibers from tendon were placed upon three leaves of one plant. The tentacles bent but did not close tightly. No change in size or appearance of the collagen particles was observed during four days.

The experiment was repeated September 23, upon a young leaf, with a result similar to the above.

September 27 and October 13 the experiment was repeated upon mature leaves, the result in each case being a bending of the tentacles within half an hour with no further change, hence the response may be attributed to contact stimulus rather than to digestion.

### LIGAMENT ELASTIN

Particles of ligament elastin were placed on a leaf of a plant in the laboratory August 26, at 2:30 P. M. Observations were made at intervals of half an hour during the first four hours, but no response was noted. Daily observations showed no response at the end of a week. On the same day elastin was placed on several leaves of each of two plants in the propagating house. No change was noted in three days.

On September 3 nine leaves of a single plant in the propagating house were washed with distilled water, after which particles of elastin which had been moistened with distilled water were placed upon them. No movement of the tentacles was observed during six days. On the same day particles of elastin which had been moistened with dilute Liebig's meat extract were placed upon two leaves of a plant in the propagating house. Observations were made on three successive days, but no change was seen. (Note the negative results with creatin recorded in the next section of this paper.)

On September 4 particles of elastin moistened with distilled water were placed upon eleven leaves of a plant in the laboratory; three hours later a slight bending of the tentacles was noted. The ollowing morning all the tentacles had recovered, without effect on the elastin. On the same day particles of dry elastin were placed upon nine leaves of a single plant in the laboratory. After three hours a slight bending of the tentacles nearest the elastin was noted, but, after an interval of twenty hours, all the tentacles had recovered. There was no effect on the elastin.

On October 13 the experiment was repeated in the laboratory with similar results.

Elastin, then, is not digested by the leaves of these plants.

## CREATIN

Creatin particles were placed upon three leaves of one plant, September 18, in the propagating house. They dissolved but caused no bending of the tentacles. The drops of fluid were present on the leaves for five days, but had disappeared entirely by the ninth day.

On September 23, the experiment was repeated upon one leaf of each of four plants. The creatin dissolved within an hour and a beadlike drop remained for three days on each tentacle upon which the creatin had fallen. No bending of tentacles nor other response occurred.

In Darwin's experiments with meat, creatin (and presumably the other nitrogenous extractives of meat) had seemingly no influence.

## GENERAL CONCLUSIONS

The results of these experiments indicate the ready digestibility of dry egg-white, fibrin, tendomucoid, and nucleoprotein. Acid-albumin, alkali albuminate, and edestin were digested, but somewhat less readily than the products first named. Collagen and elastin appeared to be entirely indigestible. Even when moistened with meat extract the elastin particles failed to undergo digestive alteration. Creatin did not cause bending of the tentacles.

These observations cannot be directly compared with Darwin's because Darwin dealt with mixtures or crude products.

The proteolytic enzymes of *Drosera* are, like those of other organisms, able to digest some proteins and unable to digest others.

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CONTRIBUTIONS FROM THE NEW YORK BOTANICAL
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# RHIPSALIS IN THE WEST INDIES

By N. L. BRITTON

NEW YORK
1909

Reprinted, without change of paging, from TORREYA 9: 153-160. 3 Au 1909.

# RHIPSALIS IN THE WEST INDIES *

By N. L. Britton

*Rhipsalis* is a genus of leafless jointed cacti, with round, angled, or flat branches and small flowers, consisting of numerous species, mostly natives of tropical America, but a few species occur in eastern tropical Africa and the widely distributed *R. Cassutha* grows also in Ceylon. In this Old World distribution the genus differs from all other cacti, the family being otherwise American in distribution, except for several Opuntias, which have become naturalized in southern Europe and northern Africa.

These African species are of great interest from the standpoint of geographic distribution because they are the only cacti native in any part of the Old World. From the large preponderance of species in America it seems certain that the ancestors of the African kinds must have been transported from the American tropics to those of Africa in past geologic time, and the method of transportation, unless there was land connection between the continents, can only be guessed at. There are many genera in other families of plants common to the American and African tropics, however, and this indicates the probability of former land connection, over which their ancestors might have spread by well-known natural means.

The genus was established by Gaertner (Fruct. & Sem. **1**: 137. 1788), the type species being *R. Cassutha* Gaertn. Adanson (Fam. Pl. **2**: 243. 1763) had previously proposed the generic name *Hariota*, for presumably the same species (Plumier, Plant. Amer. 190. *pl. 197. f. 2*), and this figure is cited by Linnaeus (Syst. ed. 10, 1054. 1759) under *Cactus parasiticus*, but Linnaeus at the same place, and before his citation of Plumier's figure, cites Sloane, Jamaica, *pl. 224. f. 3 and 4*, which is a species of *Vanilla*, probably *V. Eggersiana* Rolfe. Inasmuch as Adanson did not typify *Hariota* binominally, and as the type of *Cactus parasiticus* L. is a *Vanilla*, it would appear that the name *Hariota* must be passed over, although it was taken up by Dr. Otto Kuntze (Rev. Gen. Pl. 261. 1891), and the species of *Rhipsalis* known to him transferred to it. Through Linnaeus's blunder of uniting two widely different plants, which he knew only from illustrations, we are apparently prevented from using the name *Hariota*, and the next oldest available generic name is *Rhipsalis*.

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* Illustrated with the aid of the Catherine McManes Fund.

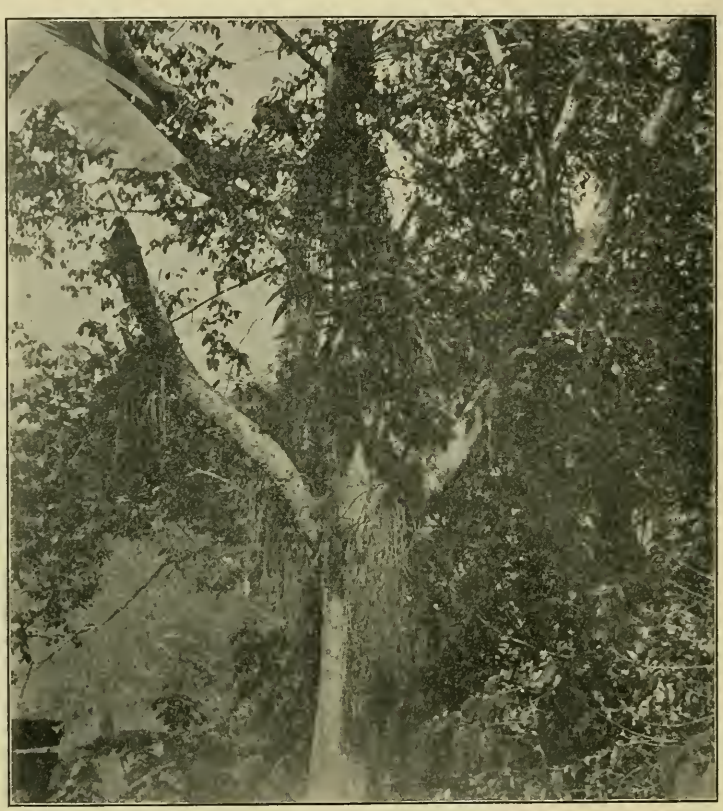

FIG. 1. *Rhipsalis Cassutha* Gaertn. Near Utuado, Porto Rico. Photographed by Dr. Marshall A. Howe.

The species of *Rhipsalis* are mainly epiphytic, drooping from trees, though sometimes found on cliffs, and they are mesophytes rather than xerophytes, inhabiting moist or wet regions. Some of them bear spines or bristles at the areoles of young shoots, which usually fall away early, leaving the mature plants quite unarmed, but a few South American species bear spines even when mature. Their flowers are whitish, yellowish, or pink, often almost rotate when widely expanded, the perianth-segments few, the perianth-tube short or none; the stamens are few or numerous and shorter than the perianth; the fruits are globular or oblong, white or yellowish berries with a watery pulp full of small seeds.

Three species are now known from the West Indies, which may be classified as follows:

Joints terete, slender (*Eurhipsalis*). 1. *R. Cassutha.*
Joints flat (*Phyllorhipsalis*).
  Joints 4–6 cm. wide; flowers 15 mm. long; berry oblong. 2. *R. alata.*
  Joints 1–2.5 cm wide; flowers 6 mm. long; berry subglobose. 3. *R. jamaicensis.*

1. **Rhipsalis Cassutha** Gaertn. Fr. & Sem. **1**: 137. 1788
*Cassytha filiformis* Mill. Gard. Dict. Ed. 8. 1768. Not L.
*Cactus parasiticus* Lam. Encycl. **1**: 541. 1783. Not L.
*Cactus pendulus* Sw. Fl. Ind. Occ. **2**: 876. 1800.
*Cactus caripensis* H.B.K. Nov. Gen. **6**: 66. 1823.
*Cereus caripensis* DC. Prodr. **3**: 467. 1828.
*Rhipsalis parasiticus* DC. Prodr. **3**: 476. 1828.
*Cactus fasciculatus* Willd. Enum. Suppl. 33. 1813.
*Rhipsalis parasitica* Haw. Syn. Pl. Succ. 187. 1812.
*Rhipsalis fasciculata* Haw. Suppl. 83. 1819.
*Rhipsalis cassythoides* G. Don, Gen. Syst. **3**: 176. 1834.
*Rhipsalis dichotoma* G. Don, Gen. Syst. **3**: 176. 1834.
*Rhipsalis undulata* Pfeiff. Enum. 156. 1837.
*Rhipsalis Hookeriana* G. Don, Gen. Syst. **3**: 176. 1834.
*Hariota parasitica* Kuntze, Rev. Gen. Pl. 262. 1891.

Plant often 1 m. long or longer, much branched, light green, pendent from trees or on cliffs, the branches flexible; flowers 6–8 mm. long; petals about 4, ovate, obtuse; stamens about 9. [FIGURE 1.]

TYPE LOCALITY: Not cited.

ILLUSTRATIONS: Gaertn. *loc. cit. pl. 28. f. 1*; Hook. Exot. Fl. **1**: *pl. 2*; Lodd. Bot. Cab. *pl. 865*; Bot. Mag. *pl. 3079, 3080*; DC. Pl. Grasses, *pl. 59*.

DISTRIBUTION: CUBA: Matanzas (*Rugel 767; Britton & Shafer 450*); Madruga (*Britton & Shafer 788*); Calicita near Cienfuegos (*Combs 470*); vicinity of San Luis, Oriente (*Pollard & Palmer 356; Maxon 4012*). HAITI: Port Margot to Corneil (*Nash 228*); La Brande to Mt. Balance (*Nash & Taylor 1660*). PORTO RICO: Yauco (*Garber 63; Sintenis 3823*); between Aibonito and Cayey (*Heller 516*); near Aibonito (*Underwood & Griggs 488*). JAMAICA: near Rio Grande Ford, Cuna Cuna Trail (*Fredholm 3207*); Belvidere (*Harris 7646*); vicinity of Castleton (*Maxon 836*); Moneague (*E. G. Britton 2956*). San Luis Potosi, Mexico, to Costa Rica, Colombia, Bolivia, Venezuela, and Brazil. Tropical Africa. Mauritius. Ceylon.

The young shoots are often quite bristly, but the mature plant becomes smooth; flowers are sometimes developed before the bristles fall away. In the West Indies the plant has not been observed by me at a greater altitude than about 500 meters.

2. **Rhipsalis alata** (Sw.) Schum. Fl. Bras. $4^2$: 288. 1890

*Cactus alatus* Sw. Prodr. 77. 1788.
*Cereus alatus* DC. Prodr. **3**: 470. 1828.
*Rhipsalis Swartziana* Pfeiff. Enum. 131. 1837.
*Hariota alata* Kuntze, Rev. Gen. Pl. 262. 1891.
*Rhipsalis Harrisii* Gürke, Monats. Kakt. **18**: 180. 1908.

Pendent from trees and on rocks, sometimes 5 meters long, with several long branches; joints broadly linear, lanceolate or linear-oblong, often constricted at the middle or above it, bluntish at the apex, decurrent below into a stipe-like base, rather fleshy, bright green, about 1 mm. thick, 2–4 dm. long, 4–6 cm. wide, the midvein prominent and stout, the margins crenate-undulate, the lower crenations 1–2 cm. long, the upper ones 4–8 mm. long, the main lateral veins ending in the sinuses; flowers yellowish-white, about 15 mm. long; petals 10, lanceolate, acutish, the outer slightly longer than the inner, erect and nearly parallel; stamens numerous, about one half as long as the petals; style slender, about three times as long as the five linear stigmas; erry ovoid, rounded at both ends, yellow-green, 1 cm. long. [FIGURE 2.]

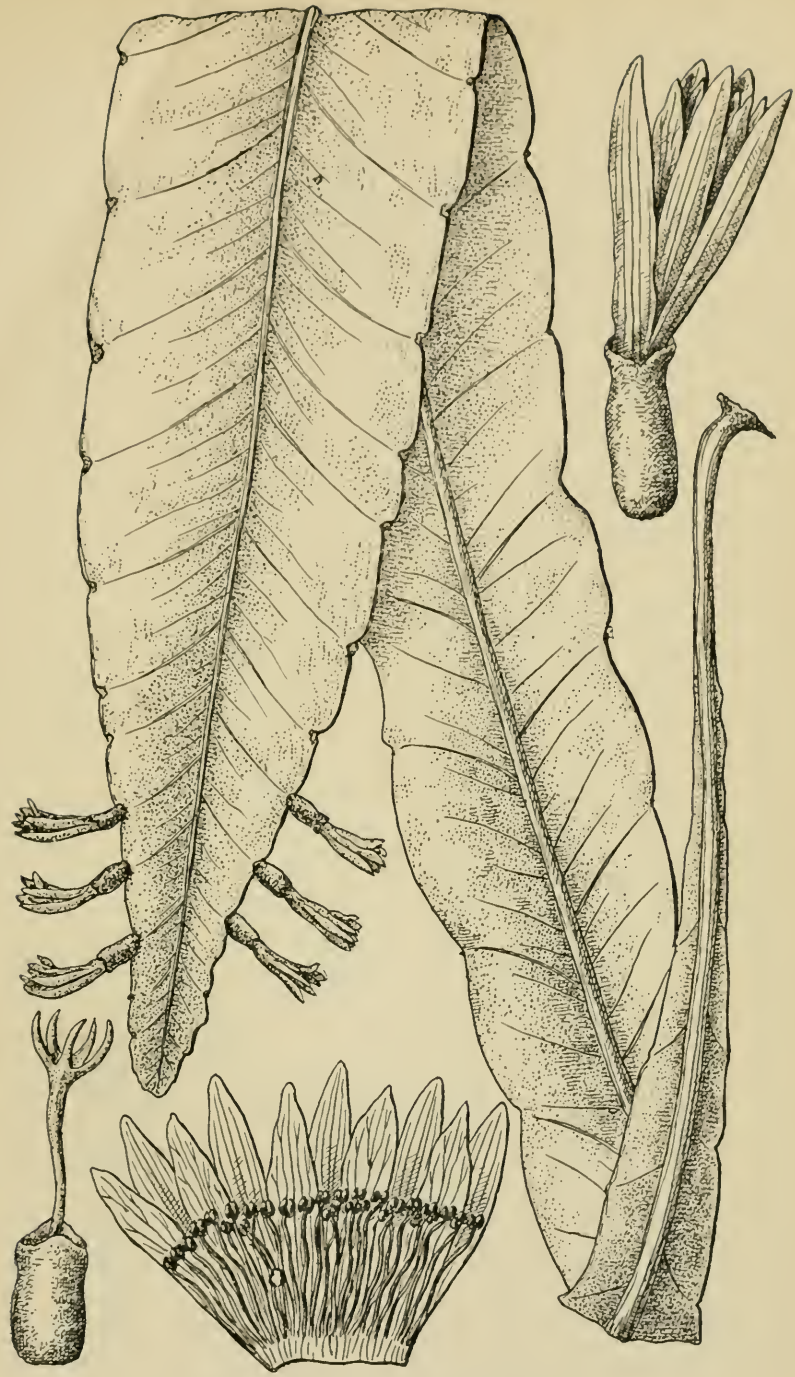

FIG. 2. *Rhipsalis alata* (Sw.) Schum.

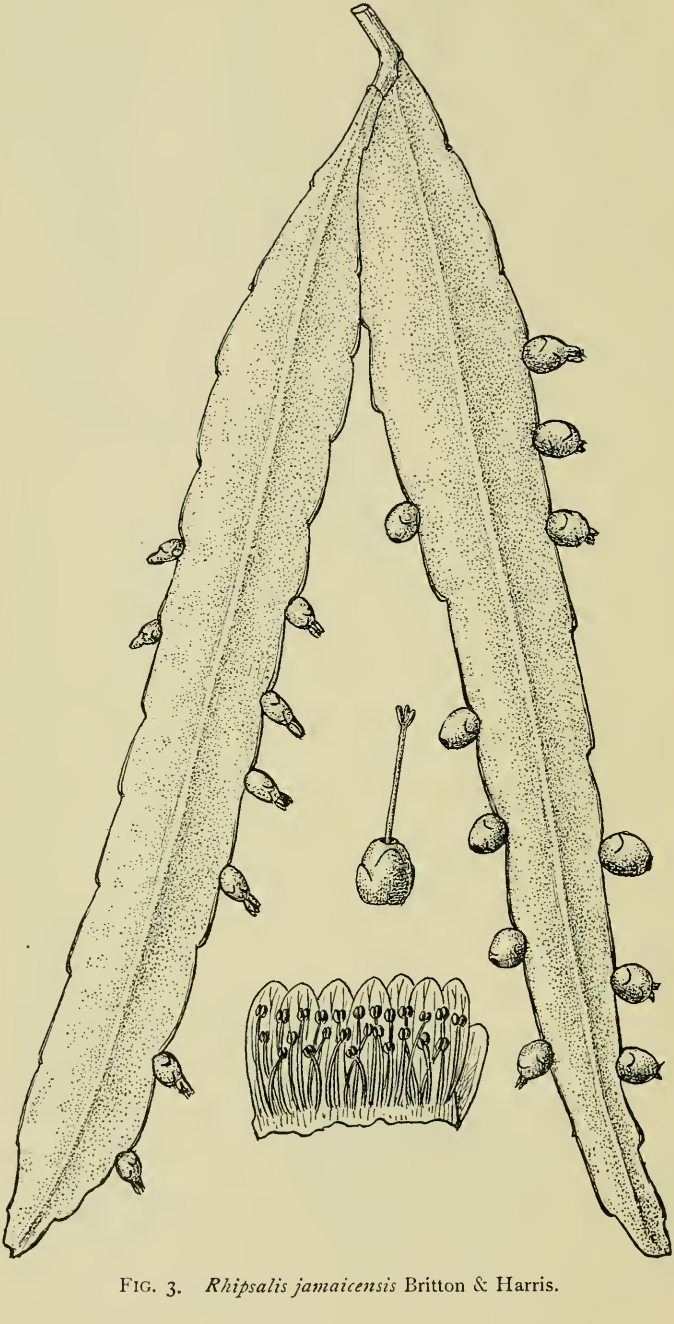

FIG. 3. *Rhipsalis jamaicensis* Britton & Harris.

JAMAICA: Woodstock, near Newmarket, Westmoreland (*Britton 1583; Harris 9995*); Belvidere, Hanover (*Harris 7619*); Kempshot, Hanover (*Britton & Hollick 2408*); Mandeville, Manchester (*Britton 3751*). The plant flowers in autumn.

This species has been misinterpreted by authors, commencing with Grisebach (Fl. Br. W. I. 302. 1860) and the name *alatus* applied to the other somewhat similar plant of Jamaica to be described below. I have satisfactorily identified it from Swartz's description, and by the aid of a tracing of a type specimen preserved in the herbarium of the British Museum of Natural History, kindly sent at my request by Mr. A. B. Rendle, and Professor Urban informs me that the Swartz specimen preserved in the Stockholm Herbarium is also certainly this species.

The name *Rhipsalis alata* is to be found incidentally mentioned under *Cereus alatus* in Steudel, Nomencl. ed. 2, **1**: 333, published in 1841, without any description of the plant referred to, and is therefore a hyponym to be disregarded.

### 3. **Rhipsalis jamaicensis** Britton & Harris, sp. nov.

Pendent from trees, the young shoots quite bristly, the older joints smooth; plant 3–10 dm. long, the main axis angular; joints 1–4 dm. long, 1–2.5 cm. wide, dull green, about 2 mm. thick, the apex bluntish, the base narrowed into a stipe 1–6 cm. long, the margins low-crenate; flowers yellowish green, about 6 mm. long, the petals about 7, oblong to oblanceolate, not very widely expanding, obtusish; ovary oblong, with a few scales; stamens 20–24; style much longer than the three oblong stigmas; berry globose, white, 6–8 mm. in diameter. [Figure 3.]

JAMAICA: Troy, Cockpit Country (*Britton 511*, type); vicinity of Troy (*Maxon 2813*); near Montpellier (*E. G. Britton 2863*); Bath to Cuna Cuna Gap (*Britton 3502*).

In "Gesamtbeschreibung der Kakteen.," p. 636, the late Professor Schumann, erroneously describing this plant as *Rhipsalis alata*, refers the Costa Rican *Rhipsalis coriacea* Polak. Linnaea **41**: 562, 1877, to it as a synonym. This species is, perhaps, its closest relative, but after growing the two side by side at the New York Botanical Garden, I am convinced that they are distinct.

Visitors to the New York Botanical Garden will find the collection of *Rhipsalis* in Range 1, House No. 7, of the public conservatories.

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CONTRIBUTIONS FROM THE NEW YORK BOTANICAL
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# NOTES ON ROSACEAE—II

By PER AXEL RYDBERG

NEW YORK
1909

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397–407. 14 Au 1909

[From the Bulletin of the Torrey Botanical Club 36: 397-407. 1909]

# Notes on Rosaceae — II

Per Axel Rydberg

## Schizonotus

In Harms' list of Genera Conservanda, adopted by the Vienna Botanical Congress, the name *Sorbaria* A. Br. of 1864 is given among those which should be retained, and it is preferred to the older *Basilima* Raf. 1836 [should have been 1838] and the still older *Schizonotus* Lindl. of 1829. Usually the publication of the last-named genus is accredited to Wallich's Catalogue.* This catalogue, however, was not published in the sense the word "published" is usually taken, for it was merely a duplicated collector's list. Besides, *Schizonotus* is there merely a *nomen nudum*, *i. e.*, being accompanied neither by a description nor by a synonym cited. In Lindley's Introduction to the Natural System of 1830, *Schizonotus* is really published, as Lindley points out the characteristic fruit of *Spiraea sorbifolia* and proposes the name *Schizonotus* on page 81, and on page 83 enumerates *Schizonotus* as a genus recognized by him. The combination *Schizonotus sorbifolius* was not actually published until eleven years later in the second edition of Steudel's Nomenclator.

Is there any good reason for preserving *Sorbaria* instead of either of the two older names? If there had been a rule providing that when a subgenus, or section of a genus, is raised to generic rank, then the subgeneric or sectional name should be retained, *Sorbaria* A. Br. would have had a standing, for as a name of a section of *Spiraea* it dates from 1825. Such a rule has been advocated to some extent in this country, but the Vienna Rules do not provide for anything like it. *Sorbaria* apparently was selected purely arbitrarily, perhaps because it had been adopted by Focke in Die Natürlichen Pflanzenfamilien. If *Sorbaria* had been a generally accepted genus, there might have been also some reason for its retention, but this is not the case. Scarcely any one has used it from its publication until it was used in the Pflanzenfamilien. If the choice had been only between *Sorbaria* and *Basilima* there might have been another reason why the former should be preferred; the latter was proposed by the erratic Rafinesque, who did things only by halves. But *Schizonotus* was proposed by Lindley, one of England's most prominent botanists. Perhaps the fact that Rafinesque applied the name *Schizonotus* to a different genus had something to do with it; but Rafinesque never intended to name a new genus *Schizonotus*, when he used it as generic name for *Spiraea discolor* Pursh. He simply thought that he was using it in the same sense as Lindley. It was simply a matter of wrong identification.

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* No. 703. 1829

### CHAMAEBATIARIA

This genus has been supposed to be monotypic. There exists, however, a second species, although it seems to be very rare and of a rather restricted distribution. *C. Millefolium* resembles the genus *Chamaebatia* in general habit and has often been mistaken for it, but this likeness is still greater in *Chamaebatiaria glutinosa.* Even to a trained botanist, who knows both, it would be hard, without flowers or fruit, to distinguish the latter from *Chamaebatia foliolosa.* The oldest specimen known of *C. glutinosa*, viz., its type, was sent to Dr. John Torrey, who wrote the following remarks on the sheet: "Given to me by Dr. Bolander, in San Francisco, Sept., 1872. The only specimen he had ever seen. We both supposed it might be a n. sp. of *Chamaebatia*, but it proves to be a *Spiraea*, nearly allied to my *S. Millefolium.* 4–5 feet high."

Besides the type, only the following specimens have been seen by the writer:

CALIFORNIA: 1855, *Newberry.*
NEVADA: *Ward;* 1885, *Mrs. Clements.*

### PORTERANTHUS

This genus was first published under the name of *Gillenia* Moench in 1802. There is, however, an older *Gillena* Adans.* named for the same person and properly published, as it was based on *Volkameria* P. Br.† and *Tinus* L.‡

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* Fam. Pl. 2: 166. 1763.
† Hist. Jam. 214. 1756.
‡ Syst. 1010. 1759. [Ed. 10.]

## LINDLEYELLA

This genus has been known as *Lindleya* H.B.K. (1823). But the name *Lindleya* had been used twice before, viz., in 1821–2 by Kunth * and by Nees.† The former is supposed to be a synonym of *Cascaria* Jacq. and the latter of *Laplacea* H.B.K.,‡ published the same year. Which of the two was first published can scarcely be decided, and *Lindleya* Nees may replace *Laplacea* H.B.K. Following the rule, "Once a synonym, always a synonym," the writer was forced to propose a new name.

That the genus contains more than one species is evident. If anyone compares the illustrations cited in the North American Flora under *L. mespiloides* with those in the Botanical Register and the Fleurs des Serres, cited under *L. Schiedeana*, he will see that they can scarcely represent the same plant. *L. mespiloides* has been described as a very variable plant, perhaps partly on account of these very unlike illustrations. There are perhaps more than two species included, but the author has no evidence that proves the existence of more than two. All the specimens found in the herbaria of the New York Botanical Garden, Harvard University, and the United States National Museum, except one, agree fairly well with the original illustration in Humboldt, Bonpland & Kunth's Nova Genera et Species. The only exception is Schiede's plant and this agrees fairly well with the illustrations in the Botanical Register and in the Fleurs des Serres.

## VAUQUELINIA

When the author began the revision of this genus, he had two species at hand, which had been named *V. corymbosa*, but the first glance at the original illustration of the latter showed him that neither of the two could belong to it. One of these was referred to *V. corymbosa* by Torrey in the Botany of the Mexican Boundary Survey. This error was corrected by Watson, who renamed the plant *V. Torreyi*. The plant had been collected earlier, however, during Emory's Reconnoissance and had been described by Torrey as *Spiraea californica*. For this reason the name was changed to *V. californica* by Sargent, although the plant is not found within the state of California. *Spiraea californica* differs, however, somewhat from *Vauquelinia corymbosa* of the Mexican Boundary Survey, having broader and less tomentose leaves. Whether the two forms represent two distinct species or not is hard to tell, as the author has seen but one specimen resembling the type of the former, and both this specimen and the type are but fragmentary.

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* Malv. 10. 1822.

† Flora 4: 299. 1821.

‡ H.B.K. Nov. Gen. et Sp. 5: 207. 1821.

The other plant, named *V. corymbosa*, is a shrub from Chihuahua and best represented by Pringle's *no. 5*. This is characterized by its narrow leaves and has therefore received the name *V. angustifolia*. It is represented by the following specimens:

MEXICO: Santa Eulalia Mountains, state of Chihuahua, 27 May, 1885, *C. G. Pringle 5* (flowers); 14 Aug., 1885, *Pringle 369* (fruit); 1885, *E. Wilkinson* (flowers).

As stated before, neither of these could be referred to *V. corymbosa* Correa. Neither could they be referred to *V. Karwinskyi* Maxim. Of the latter I had seen no specimen, but Maximowicz's description was ample enough to determine this fact. The author therefore made a key and drew the description of the four species as well as he could from the herbarium material of two of them and the descriptions of the two others. While the monograph was in press some material was received from Washington, and in this material were found specimens of the two missing species. There was, however, only little to be added or modified in the descriptions. *V. corymbosa* is represented by the following specimens:

MEXICO: Ixmiquilpan, Hidalgo, Aug., 1905, *C. A. Purpus 1384*.

*V. Karwinskyi* by the following:

MEXICO: Alvarey, San Luis Potosi, May 19–22, 1905, *E. Palmer 594;* perhaps also, San Lorenzo Cañon, six miles southeast of Saltillo, Coahuila, April 16, 1905, *E. Palmer 538*.

## SERICOTHECA

According to the Vienna Rules and Harms' list, *Holodiscus* Maxim. should be retained in preference to *Schizonotus* Raf. If there were any regard to priority, such a provision would be unnecessary, for *Schizonotus* Raf. (1838) is a homonym of the older

*Schizonotus* Lindl. (1830). But why should not *Sericotheca* Raf. (1838) be considered? It was just as well published as was *Schizonotus*, and was published by the same author. It is another illustration of how poorly digested and how incomplete Harms' list is. The present writer would perhaps be willing to subscribe to a list of *nomina conservanda*, provided that a good reason in each case could be given; but a list which arbitrarily retains or rejects genera published under similar conditions by Hill or Adanson, as shown by Druce in his introduction to his List of British Plants, has no standing with the present writer.

The genus *Sericotheca* is a very perplexing one, and it is very hard to draw lines between the species. Otto Kuntze reduced the whole genus to one species. Every one must admit that by so doing he went too far. The genus can be divided into two types; one with the teeth of the leaves rounded or rounded-ovate, ending in a short mucro, and achenes straight on the back; the other with the teeth lanceolate or triangular-ovate, ending in a long mucro, and the achenes more or less curved on the back. The two species would then be *S. discolor* and *S. argentea*. This would be the ultra-conservative view. Both species, especially the former, would, however, show such a diversity of forms that a number of varieties would have to be admitted. If S. *discolor* is compared with *S. microphylla* or *S. glabrescens*, few botanists would regard them as the same species. It is only when the other members of the genus are known and considered, that some would regard them as varieties of one species. C. K. Schneider, who can very well be credited to the conservative school, has been forced to admit four species. He made the statement that he could not see any difference between *Holodiscus microphyllus* and *H. dumosus* but I think this was due to the fact that he followed S. Watson in his interpretation of *H. dumosus*. Watson's idea of *H. dumosus* was an aggregate of those species which have a narrow and rather simple inflorescence, *i. e.*, *Sericotheca concolor*, *S. microphylla*, and *S. glabrescens*. *S. Boursieri* and *S. saxicola* would also have been included, had they been known to Watson. Now, the fact is that the original *Spiraea dumosa* Nutt. cannot be distinguished specifically from *Holodiscus australis* Heller. The latter Schneider admits as a good species. It is true that *Spiraea* *dumosa* Nutt. and *Holodiscus australis* Heller are not exactly alike. The former represents the extreme hairy form with more than usually double toothed leaves and the latter the more glabrate extreme with simpler teeth.

It was with some reluctance that the writer proposed his new species *S. franciscana*, not because the type is not amply distinct from *S. discolor*, but because there are forms that connect the two. The former is characterized by its thick, dark green leaves, densely short-hairy, almost velvety above; the latter by its thin leaves, glabrous or almost so above. The following specimens are to be referred to *S. franciscana*:

CALIFORNIA: Monterey, on the Mexican Boundary Survey, 1850, *C. C. Parry*; Southern Upper California, *Fitch 2* and *3*; Sonoma (Whipple's Exploration), *Bigelow 4*; Pilarcitos, Sept., 1867, *N. J. Davis 48*; San Leandro, June, 1888, *Underwood* (type); Albion Ridge, Mendocino County, June, 1903, *J. McMurphy 266*; Crystal Spring Lake, June, 1903, *Elmer 4274*; [no locality], *Thomas Bridges 100(a)*; 1868–'9, *Kellogg & Harford 201*; Crystal Spring Lake, Sept. 2, 1902, *Baker 1552*; Ukiah, Mendocino County, July 11, 1902, *Heller*; Duncan's Mills, July 18, 1882, *M. E. Jones 3579*; Santa Lucia Mountains, June, 1898, *R. A. Plaskett 161*; Mendocino, June, 1898, *H. E. Brown 805*; Coast Hills, San Luis Obispo County, May, 1885, *Mrs. Summers 95*.

*S. pachydisca* Rydb. of Mexico is intermediate between *S. discolor* and *S. dumosa* in leaf-form, but differs from both in the much more developed disk in the mouth of the hypanthium. This may be the same as *Schizonotus argenteus intermedius* O. Kuntze, but Kuntze's description is too incomplete.

It is strange that *Spiraea Boursieri* Carr. has not been recognized, notwithstanding the excellent figure published in the Revue Horticole.* The few specimens in existence in our herbaria have been included in *S. dumosa*, as interpreted by S. Watson, perhaps on account of its small and simple inflorescence. *S. Boursieri* differs, however, from *S. microphylla* and *S. concolor* in the shape of the leaves and the much larger flowers. It has the largest flowers of all the United States species known. To it may be referred:

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* 1859: *f. 108*.

California: Yosemite Valley, 1872, *J. Torrey; Thomas Bridges 100.*

Nevada: Clear Creek Cañon, Ormsby County, Aug. 6, 1902, *Baker 1431.*

To *S. concolor* are referred, besides the type:

California: Long Meadow, Tulare County, June 7–14, 1888, *Edward Palmer 187;* Mt. San Antonio, July, 1901, *Le Roy Abrams 1917;* Coyote Creek, July 30, 1904, *Culbertson* [Baker's distribution no.] *4332.*

Nevada: Western Nevada, 1865, *Stretch;* Pine Forest Mountains, July, 1901, *Griffiths & Morris 196.*

To *S. Schaffneri* are referred the following:

Mexico: San Luis Potosi, 1879, *Schaffner 451; Parry & Palmer 223.*

Arizona: Bill Williams Mountains, June, 1883, *H. H. Rusby 588.*

*S. obovata* is closely related to *S. glabrescens*, but differs in the larger leaves, which are densely villous-pubescent above. It resembles also *S. dumosa* but its leaves are decidedly glandular-atomiferous. The following specimens are referred to it:

California: Woods on Truckee River, July 17, 1886, *Sonne* (type); Bear Valley, Calaveras County, Aug. 23, 1892, *Geo. Hansen 234.*

*Spiraea fissa* Lindl. has been improperly understood. By the courtesy of the Director of the Kew Gardens, the New York Botanical Garden has received a fine tracing of the type and also some fragments. Kuntze's type of *Schizonotus argenteus alpestris* is now in the herbarium of the N. Y. Botanical Garden and there is also a duplicate of *Holodiscus argenteus bifrons* Focke. The former is merely a reduced form and the latter a rather luxuriant one of *S. fissa.* Neither deserves even a varietal rank. Kuntze recognized also a var. *fissus*, based on *Spiraea fissa* Lindl. Although he placed the two varieties in different divisions of the key, they can not be separated. The key is not workable, and as he cites no specimens, some of his varieties will remain unknown. The var. *alpestris* is the only one represented in his herbarium.

*S. velutina* is a closely related species, which has been confused with it and with *S. argentea.* It has the habit of *S. fissa*, but has more hairy leaves and fruit like that of *S. argentea.* It may be *Schizonotus argenteus mexicanus* O. Kuntze, but it is scarcely *Spiraea mexicana* Schiede. I refer to it the following specimens:

MEXICO: Sierra de San Filipe, Oaxaca, Sept. 25, 1894, *Charles L. Smith 821*; 1894, *E. W. Nelson 1085*; 1894, *Pringle 5734.*

### FILIPENDULA

As represented in North America, this genus could very well be divided into 4 genera, viz.:

1. ULMARIA Hill, with *F. Ulmaria* and *F. denudata.*
2. FILIPENDULA Adans., with *F. Filipendula.*
3. THECANISIA Raf., with *F. rubra.*
4. [Unnamed], with *F. kamtschatica* and *F. occidentalis.*

Several of the Asiatic species, however, combine the characters of two or more of these genera and the generic lines disappear altogether. It was therefore deemed advisable to keep them as a single genus.

### HORKELIA

Three species of this genus had been published since my Monograph of the North American Potentilleae.* These are: *H. glandulosa* Eastwood, *H. Wilderae* Parish, and *H. Rydbergii* Elmer. All of these are known from the type localities only. Six were proposed as new in the North American Flora, viz.: *H. truncata, H. Brownii, H. tenuisecta, H. integrifolia, H. pulchra,* and *H. hispidula.* Of these *H. truncata* and *H. tenuisecta* were partly known to the writer when his monograph was prepared, but were there included in other species. Two sheets of the former were included in *H. platycalyx* which it resembles in floral structure. These specimens were:

LOWER CALIFORNIA: Guadalupe Mountains, 1883, *C. R. Orcutt 840* (labeled *Horkelia californica paucifoliata* Wats.).

They were not very good specimens and therefore not so critically studied. Better specimens have been seen since. The best of these is in the herbarium of the University of California. Although the specimen was from a cultivated plant, it was designated as the type.

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* Mem. Dep. Bot. Columbia Univ. **2**: 1898.

*H. tenuisecta* was better known, but the author mistook it for *H. tenella* (*H. fusca tenella* S. Wats.). A reexamination of the type of the latter proved it to belong to a species which the writer thought undescribed. *H. tenuisecta* is therefore the same as *H. tenella*, in greater part, of the writer's monograph. To it belong the following specimens:

WASHINGTON: Falcon Valley, July 28, 1882, *Suksdorf 2492* (type), and 1896, *60*; Ice Cave, Trout Lake, Aug. 5, 1894, *F. E. Lloyd.*

To the true *H. tenella* belong the following:

CALIFORNIA: San Joaquin River, Fresno Co., 1891, *Coville & Funston 1836*; Hogg Ranch, Yosemite National Park, 1902, *Hall & Babcock 3378*; Morgan, Tehama Co., 1903, *4392*; Cannell Meadows, Tulare Co., 1904, *5117*.

*Horkelia hispidula* is related to *H. sericata* but lacks the silvery pubescence characteristic of that species. In habit it resembles *H. Micheneri* also and may easily be mistaken for it, if the floral characters are overlooked, the sepals and bractlets being very different. *H. hispidula* is known only from the type locality.

*H. Brownii* is related to *H. tenella* and *H. parviflora*. It differs from the former in the dense pubescence and from the latter in the deeply divided leaflets and the open inflorescence. To it is to be referred the following specimen, besides the type:

CALIFORNIA: Mt. Shasta, 1892, *E. Palmer 2448a*.

*H. integrifolia* is related to *H. tridentata* but differs in the entire leaflets and the appressed pubescence of the stem and the petioles. It is known only from the type locality.

*H. pulchra* is related to *H. congesta* but the leaflets are 13–17 instead of about 9 and they are deeply cleft into lanceolate divisions. It also is known only from the type station.

One change of name was necessary. *H. bernardina* Rydb. was substituted for *H. Parryi* Rydb., there being an older *H. Parryi* Greene. *H. Parryi* Rydb. was based on *H. Bolanderi Parryi* S. Wats. It may be that Dr. Greene had the latter in mind, when he proposed the new species, but there is no evidence that he did, for he cited no synonym, nor in any other way referred to Watson's variety. The types of both *H. Bolanderi Parryi* S. Wats. and *H. Parryi* Greene were collected by Parry in southern California, but at different localities and in different years.

## HORKELIELLA

The writer thought it advisable to raise the subgenus *Horkeliella* of *Horkelia* to generic rank. Even if the characters separating it from *Horkelia* and *Ivesia* are not very prominent ones, the writer's opinion is that the arrangement here adopted will make the treatment of the tribe much clearer. To the two species included in the subgenus is to be added a third one, *Horkelia Congdonis.*

## IVESIA

The writer restored this genus in the North American Flora, after having included it in *Horkelia* in his Monograph of the North American Potentilleae. In the latter publication he reduced it, simply because one species, *I. argyrocoma*, has more or less dilated filaments. The species is in every other respect as good a species of *Ivesia* as any of the *I. unguiculata* group. The type species of the genus, *I. Gordonii*, has but 5 stamens and a more scape-like stem, but the structure of the flower and the general habit are otherwise practically the same. In *I. pygmaea*, *I. Shockleyi*, *I. setosa*, and *S. Baileyi*, the hypanthium is much flatter than usual in the genus; it has a distinct thickening or disk in the throat, and the filaments are short, inclined towards the center of the flower, thus approaching the structure of the flowers of the genus *Comarella.* These species (except sometimes the last one) have leaves with spinulose-tipped teeth or lobes, and only 5 stamens. It is not advisable to remove these species from *Ivesia*, however, for at least the first two have otherwise the habit of *I. Gordonii* and other 5-stamened species of the *I. lycopodioides* group; and another species, *I. chaetophora* Rydb., has the same habit and the same spinulose-tipped teeth or divisions, but a more campanulated hypanthium, no thickened disk, and 10 stamens.

The species of the *I. eremica* group approach the genus *Potentilla* in the almost clawless petals and the less developed hypanthium, but otherwise they are typical Ivesias.

The following species were proposed as new: *I. Tweedyi*, *I. megalopetala*, and *I. setosa.*

The first one was included in *Horkelia utahensis* in my Monograph; the other two were there treated as varieties of *H. Gordonii* and *H. Baileyi*, respectively.

To *I. Tweedyi* belong, besides the type, the following specimens:

WASHINGTON: Cascade Mountains, 1882, *T. S. Brandegee.*

*I. callida* (Hall) Rydb. was transferred from *Potentilla*, and placed in the *I. eremica* group, although not so closely related to the other members.

### PURPUSIA

*P. saxosa* is still unknown except from the type locality. Other specimens have been referred to this species, as for instance, *Heller 8297*, but this belongs to *Potentilla acuminata* Hall; some others belong to *Potentilla saxosa* Lemmon. *Ivesia Baileyi* may also be mistaken for it. The few pistils on a stalked receptacle and the absence of bractlets distinguish it at a glance from all three.

### COMARELLA AND STELLARIOPSIS

These two genera were treated as in my monograph.

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